

INSTALLATION RESTORATION PROGRAM

PRELIMINARY ASSESSMENT

273rd Engineering Installation Squadron

Nederland Air National Guard Station
Texas Air National Guard
Nederland, Texas

December 1990

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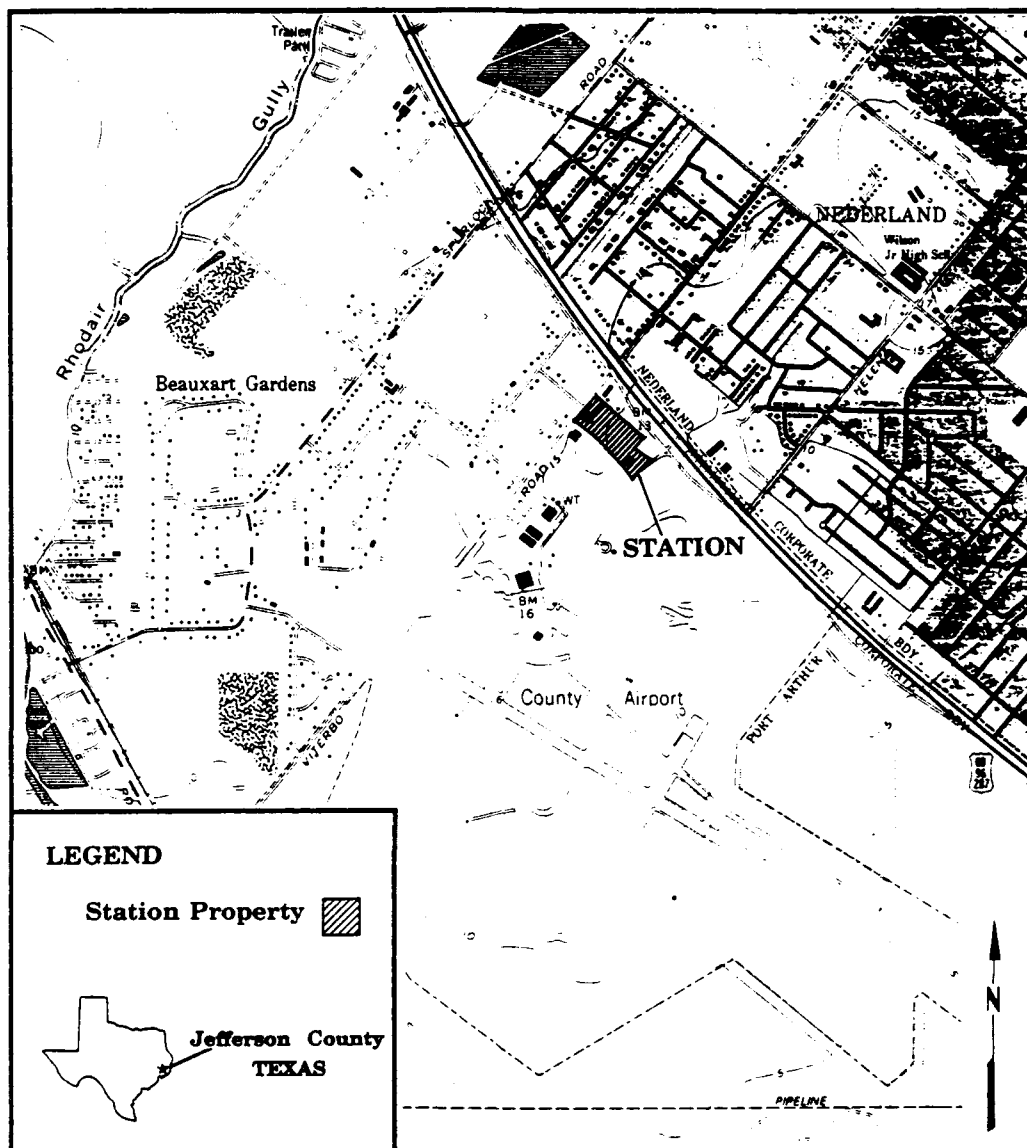
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Preliminary environmental assessment for Nederland Air National Guard Station, as part of the Installation Restoration Program. The report reflects data gathered from records review, interviews, and a site visit. One site was identified as potentially contaminated and was recommended for further investigation.

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PRELIMINARY ASSESSMENT**

**273rd ENGINEERING INSTALLATION SQUADRON
NEDERLAND AIR NATIONAL GUARD STATION
TEXAS AIR NATIONAL GUARD
NEDERLAND, TEXAS**

Prepared for

National Guard Bureau
Andrews Air Force Base, Maryland 20331-6008

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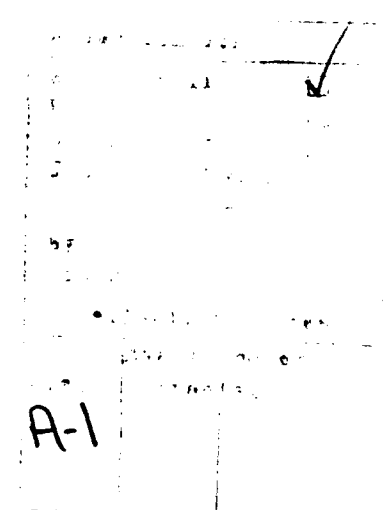


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ACRONYM LIST

AGE	Aerospace Ground Equipment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
EIS	Engineering Installation Squadron
EO	Executive Order
EPA	Environmental Protection Agency
FR	Federal Register
FS	Feasibility Study
HARM	Hazard Assessment Rating Methodology
HAS	Hazard Assessment Score
HAZWRAP	Hazardous Waste Remedial Actions Program
IRP	Installation Restoration Program
MOGAS	Automotive Gasoline
NGB	National Guard Bureau
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyl
PL	Public Law
POC	Point of Contact
RCRA	Resource Conservation and Recovery Act of 1976
R&D	Research and Development
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act of 1986
SciTek	Science & Technology, Inc.
SI	Site Investigation
USAF	United States Air Force
USC	United States Code
UTA	Unit Training Assembly

EXECUTIVE SUMMARY

A. INTRODUCTION

Science & Technology, Inc. (SciTek) was retained to conduct the Installation Restoration Program (IRP) Preliminary Assessment (PA) of the 273rd Engineering Installation Squadron (EIS), Nederland Air National Guard Station [hereinafter referred to as the Station] located at Nederland, Texas. For the purpose of this document, the Station shall include the total area leased by the 273rd EIS at Nederland, Texas.

The PA included the following activities:

- o an on-site visit, including interviews with a total of six persons familiar with Station operations, and field surveys by SciTek representatives during June 18-22, 1990;
- o acquisition and analysis of information on past hazardous materials use, waste generation, and waste disposal at the Station;
- o acquisition and analysis of available geological, hydrological, meteorological, and environmental data from federal, state, and local agencies; and
- o the identification and assessment of sites on the Station that may have been contaminated with hazardous wastes.

B. MAJOR FINDINGS

The 273rd EIS has used hazardous materials and generated small amounts of wastes in mission-oriented operations and maintenance at the Station since 1957.

Operations that have involved the use of hazardous materials and the disposal of hazardous wastes include vehicle maintenance and maintenance of aerospace ground equipment (AGE). The hazardous wastes disposed of through these operations include varying quantities of fuels, acids, paints, thinners, strippers, solvents, and oils.

The field surveys and interviews resulted in one site being identified that exhibits the potential for contaminant presence and migration.

C. CONCLUSIONS

It has been concluded there is one site where a potential for contaminant presence exists. This site is as follows:

Site No. 1 - Underground Storage Tank at Building 3 (HAS - 63)

D. RECOMMENDATIONS

Further work under the IRP is recommended for the identified site to determine the presence or absence of contamination.

I. INTRODUCTION

A. Background

The 273rd Engineering Installation Squadron (EIS), Nederland Air National Guard Station [hereinafter referred to as the Station] is located at Nederland, Texas. The 273rd EIS has been active at its present location since 1957. Both the past and current operations have involved the use of potentially hazardous materials and the disposal of wastes. Because of the use of these materials and the disposal of resultant wastes, the National Guard Bureau (NGB) has implemented the Installation Restoration Program (IRP).

The IRP is a comprehensive program designed to:

- o Identify and fully evaluate suspected problems associated with past hazardous waste disposal and/or spill sites on Department of Defense (DoD) installations and
- o Control hazards to human health, welfare, and the environment that may have resulted from these past practices.

During June 1980, DoD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM 80-6) requiring identification of past hazardous waste disposal sites on DoD installations. The policy was issued in response to the Resource Conservation and Recovery Act of 1976 (RCRA) and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, Public Law (PL) 96-510), commonly known as "Superfund." In August 1981, the President delegated certain authority specified under CERCLA to the Secretary of Defense via an Executive Order (EO 12316). As a result of EO 12316, DoD revised the IRP by issuing DEQPPM 81-5 (December 11, 1981), which reissued and amplified all previous directives and memoranda.

Although the DoD IRP and the Environmental Protection Agency (EPA) Superfund programs were essentially the same, differences in the definition of program activities and lines of authority resulted in some confusion between DoD and state/federal regulatory agencies. These difficulties were rectified via passage of the Superfund Amendments and Reauthorization Act (SARA, PL-99-499) of 1986. On January 23, 1987, Presidential Executive Order EO 12580 was issued. EO 12580 effectively revoked EO 12316 and implemented the changes promulgated by SARA.

The most important changes effected by SARA included the following:

- o Section 120 of SARA provides that federal facilities, including those in DoD, are subject to all provisions of CERCLA/SARA concerning site assessment, evaluation under the National Contingency Plan [40CFR300], listing on the National Priorities List, and removal/remedial actions. DoD must therefore comply with all the procedural and substantive requirements (guidelines, rules, regulations, and criteria) promulgated by the EPA under Superfund authority.
- o Section 211 of SARA also provides continuing statutory authority for DoD to conduct its IRP as part of the Defense Environmental Restoration Program (DERP). This was accomplished by adding Chapter 160, Sections 2701-2707 to Title 10 United States Code (10 USC 160).
- o SARA also stipulated that terminology used to describe or otherwise identify actions carried out under the IRP shall be substantially the same as the terminology of the regulations and guidelines issued by the EPA under their Superfund authority.

As a result of SARA, the operational activities of the IRP are currently defined and described as follows:

- o **Preliminary Assessment**

The Preliminary Assessment (PA) process consists of personnel interviews and a records search designed to identify and evaluate past disposal and/or spill sites that might pose a potential and/or actual hazard to public health, public welfare, or the environment. Previously undocumented information is obtained through the interviews. The records search focuses on obtaining useful information from aerial photographs; Station plans; facility inventory documents; lists of hazardous materials used at the Station; Station subcontractor reports; Station correspondence; Material Safety Data Sheets; federal/state agency scientific reports and statistics; federal administrative documents; federal/state records on endangered species, threatened species, and critical habitats; documents from local government offices; and numerous standard reference sources.

- o **Site Inspection/Remedial Investigation/Feasibility Study**

The Site Inspection consists of field activities designed to confirm the presence or absence of contamination at the potential sites identified in the PA. An expanded Site Inspection has been designed by the Air National Guard as a Site Investigation. The Site Investigation (SI) will include additional field tests and the installation of monitoring wells to

provide data from which site-specific decisions regarding remediation actions can be made. The activities undertaken during the SI fall into three distinct categories: screening activities, confirmation and delineation activities, and optional activities. Screening activities are conducted to gather preliminary data on each site. Confirmation and delineation activities include specific media sampling and laboratory analysis to confirm either the presence or the absence of contamination, levels of contamination, and the potential for contaminant migration. Optional activities will be used if additional data is needed to reach a decision point for a site. The general approach for the design of the SI activities is to sequence the field activities so that data are acquired and used as the field investigation progresses. This is done in order to determine the absence or presence of contamination in a relatively short period of time, optimize data collection and data quality, and to keep costs to a minimum.

The Remedial Investigation (RI) consists of field activities designed to quantify and identify the potential contaminant, the extent of the contaminant plume, and the pathways of contaminant migration.

If applicable, a public health evaluation is performed to analyze the collected data. Field tests, which may necessitate the installation of monitoring wells or the collection and analysis of water, soil, and/or sediment samples, are required. Careful documentation and quality control procedures in accordance with CERCLA/SARA guidelines ensure the validity of data. Hydrogeologic studies are conducted to determine the underlying strata, groundwater flow rates, and direction of contaminant migration. The findings from these studies result in the selection of one or more of the following options:

1. **No Further Action** - Investigations do not indicate harmful levels of contamination that pose a significant threat to human health or the environment. The site does not warrant further IRP action, and a Decision Document will be prepared to close out the site.
2. **Long-Term Monitoring** - Evaluations do not detect sufficient contamination to justify costly remedial actions. Long-term monitoring may be recommended to detect the possibility of future problems.
3. **Feasibility Study** - Investigation confirms the presence of contamination that may pose a threat to human health and/or the environment, and some sort of remedial action is indicated. The Feasibility Study (FS) is therefore designed and developed to identify and select the most appropriate remedial action. The FS may include individual sites, groups of sites, or all sites on an

installation. Remedial alternatives are chosen according to engineering and cost feasibility, state/federal regulatory requirements, public health effects, and environmental impacts. The end result of the FS is the selection of the most appropriate remedial action with concurrence by state and/or federal regulatory agencies.

o **Remedial Design/Remedial Action**

The Remedial Design involves formulation and approval of the engineering designs required to implement the selected remedial action. The Remedial Action is the actual implementation of the remedial alternative. It refers to the accomplishment of measures to eliminate the hazard or, at a minimum, reduce it to an acceptable limit. Covering a landfill with an impermeable cap, pumping and treating contaminated groundwater, installing a new water distribution system, and in situ biodegradation of contaminated soils are examples of remedial measures that might be selected. In some cases, after the remedial actions have been completed, a long-term monitoring system may be installed as a precautionary measure to detect any contaminant migration or to document the efficiency of remediation.

o **Research and Development**

Research and Development (R&D) activities are not always applicable for an IRP site but may be necessary if there is a requirement for additional research and development of control measures. R&D tasks may be initiated for sites that cannot be characterized or controlled through the application of currently available, proven technology. It can also, in some instances, be used for sites deemed suitable for evaluating new technologies.

o **Immediate Action Alternatives**

At any point, it may be determined that a former waste disposal site poses an immediate threat to public health or the environment, thus necessitating prompt removal of the contaminant. Immediate action, such as limiting access to the site, capping or removing contaminated soils, and/or providing an alternate water supply may suffice as effective control measures. Sites requiring immediate removal action maintain IRP status in order to determine the need for additional remedial planning or long-term monitoring. Removal measures or other appropriate remedial actions may be implemented during any phase of an IRP project.

B. Purpose

The purpose of this IRP PA is to identify and evaluate suspected problems associated with past waste handling procedures, disposal sites, and spill sites on Station property.

The potential for migration of hazardous contaminants was evaluated by visiting the Station, reviewing existing environmental data, analyzing Station records concerning the use of hazardous materials and the generation of hazardous wastes, and conducting interviews with current Station personnel who had knowledge of past waste disposal techniques and handling methods. Pertinent information collected and analyzed as part of the PA included a records search of the history of the Station; the local geological, hydrological, and meteorological conditions that might influence migration of contaminants; and ecological settings that indicate environmentally sensitive conditions.

C. Scope

The scope was limited to the identification of sites at or under primary control of the Station and evaluation of potential receptors. The PA included:

- o an on-site visit and field surveys during the period June 18-22, 1990;
- o acquisition of records and information on hazardous materials use and waste handling practices;
- o acquisition of available geological, hydrological, meteorological, land use and zoning, critical habitat, and related data from federal and state agencies;
- o a review and analysis of all information obtained; and
- o preparation of a summary report to include recommendations for further action.

The subcontractor effort was conducted by the following Science & Technology, Inc. (SciTek) personnel: Mr. Ray S. Clark, Civil/Environmental Engineer; and Mr. P. J. McMullen, Geologist/Hydrogeologist. Ms. Carol Ann Beda of the NGB is Project Officer for this Station and participated in the overall assessment during the Station visit. Mr. Larry Janssen of the Hazardous Waste Remedial Actions Program (HAZWRAP) also participated in the Station visit.

The point of contact (POC) at the Station was Major Merrell C. Schriver (Detachment Commander). In addition, Major Sheila F. Hooten represented the Host Base, Ellington Field, Houston, Texas.

D. Methodology

The PA began with a visit to the Station to identify all operations that may have used hazardous materials or may have generated hazardous wastes. Figure I.1 is a flow chart of the PA methodology.

A total of six current and past Station employees familiar with the various operating procedures was interviewed. These interviews were conducted to determine those areas where waste materials (hazardous or nonhazardous) were used, spilled, stored, disposed of, or released into the environment. The interviewees' knowledge and experience with Station operations averaged 22 years and ranged from 14 to 29 years. Records contained in the Station files were collected and reviewed to supplement the information obtained from the interviews.

Detailed geological, hydrological, meteorological, and environmental data for the area were obtained from the appropriate federal and state agencies. A listing of federal and state agency contacts is included as Appendix A.

After a detailed analysis of all the information obtained, one potential site was identified to be potentially contaminated with hazardous wastes. Under the IRP program, when sufficient information is available, sites are numerically scored and assigned a Hazard Assessment Score (HAS) using the Air Force Hazard Assessment Rating Methodology (HARM). However, the absence of a HAS does not necessarily negate a recommendation for further IRP investigation, but rather, may indicate a lack of data. A description of HARM is presented in Appendix B.

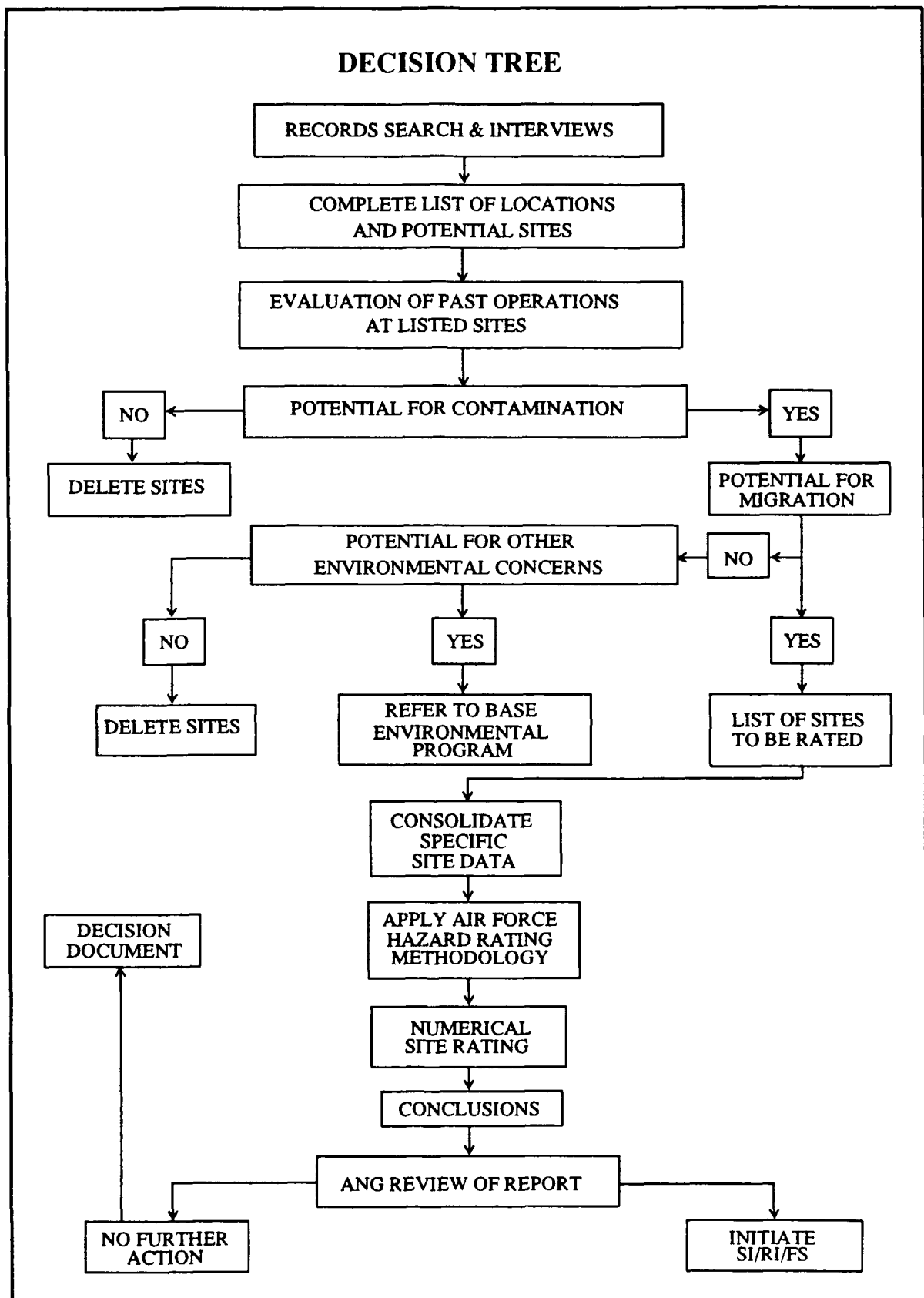


Figure I.1
Preliminary Assessment Methodology Flow Chart

II. INSTALLATION DESCRIPTION

A. Location

The Station is located approximately 9 miles northwest of Port Arthur and is adjacent to Jefferson County Airport within Jefferson County, Texas. It is approximately 12 miles south-southeast of Beaumont, Texas. The major route to the Station is the Beaumont-Port Arthur Road (Hwy 69, 96, 287).

The Station occupies approximately seven acres along Viterbo Road. Figure II.1 illustrates the location and boundaries of the Station. On weekdays, the population at the Station is approximately 19. Unit Training Assembly (UTA) occurs one weekend per month. The Station population during this weekend is approximately 173. The Station is completely fenced with controlled access. The unimproved acreage is used to conduct training and for parking of equipment.

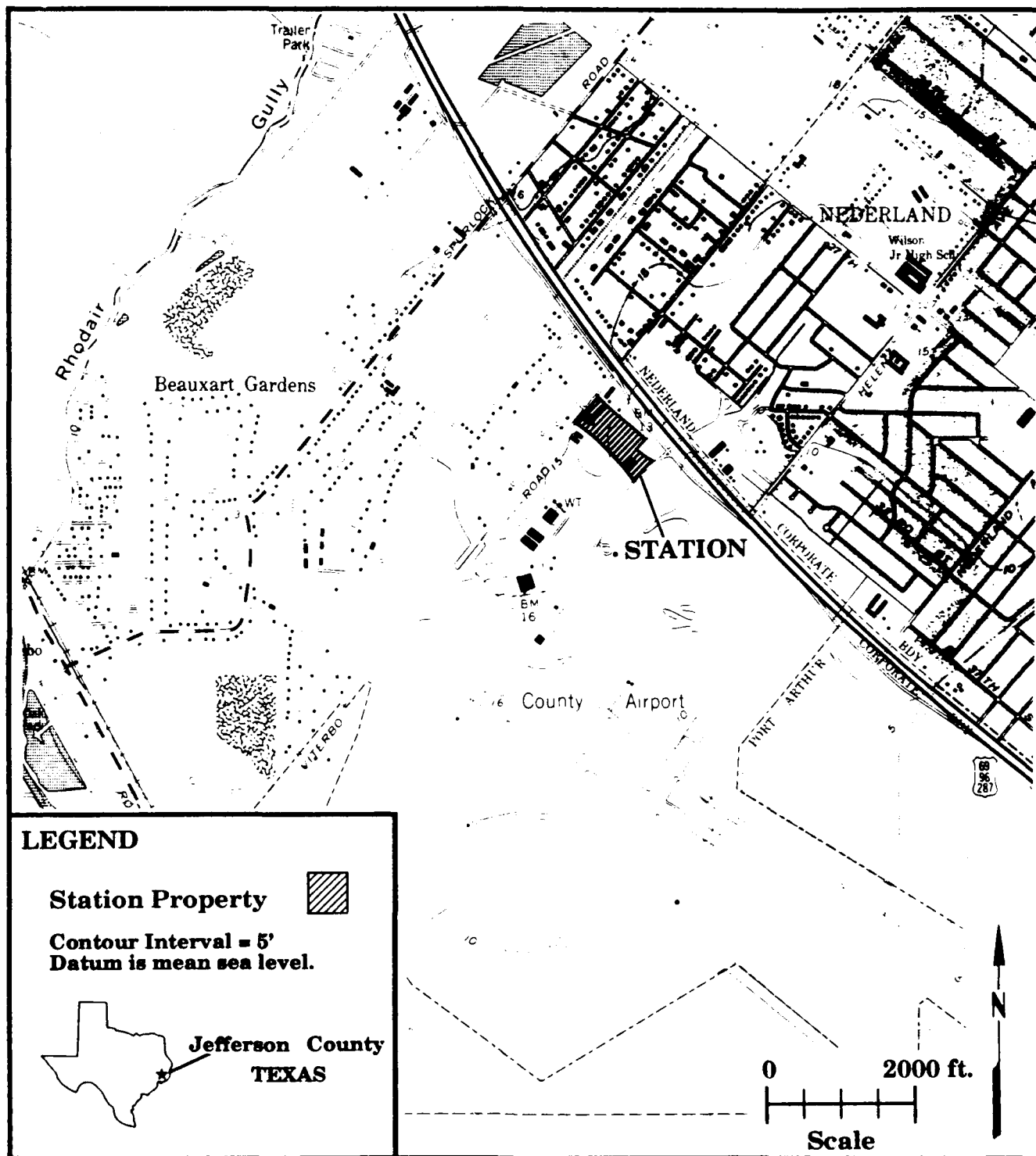
B. Organization and History

In early 1957, the 273rd Communications Squadron shared armory facilities with the Texas Army National Guard until the Army Guard moved to Beaumont. The mission of the 273rd Communications Squadron was to train personnel to provide communication facilities for a wing or higher headquarters.

In October of 1960, the squadron was reorganized as the Ground Electronics Engineering Installation Agency, requiring more personnel and equipment. Therefore, facilities had to be increased. Building 2 was constructed in 1966. In 1976, the Headquarters (Building 13) was remodeled.

From 1960 until 1970, the unit had been assigned to the Air Force Logistics Command-Ground Electronics Engineering Installation Agency Unit. In 1970, the unit was redesignated the 273rd Electronics Installation Squadron under the Air Force Communication Service. The 273rd Electronic Installation Squadron was redesignated the 273rd Engineering Installation Squadron in December of 1982.

Today, the mission of the 273rd is essentially unchanged. The mission is to train all personnel to the degree that they will be capable of supporting Air Force Communications Command wartime requirements for engineering, installation, removal, and relocation of communication-computer systems facilities. The 273rd performs serviceability certification, emergency and/or programmed on-site repair, and modification of communication-computer systems equipment.



SOURCE: Port Acres Quad N2952.5-W9400/7.5, 1962, (photorevised 1970, 1974).

Figure II.1
Location Map of
the Nederland Air National Guard Station

The unit's mission necessitates the use of potentially hazardous materials that require disposal. These hazardous materials include waste oils, fuels, solvents, paints, and thinners. Such materials are largely generated in vehicle maintenance. AGE maintenance occurs within the vehicle maintenance shop when needed. Washrack activity and the routine maintenance of vehicles, generators, and other equipment results in varying quantities of hazardous materials. In the past, hazardous materials have been collected and stored for disposal. From 1960 until 1985, liquid wastes were stored in an underground tank. These liquids were disposed of by a contractor. Presently, wastes are collected and disposed of by a contractor.

III. ENVIRONMENTAL SETTING

A. Meteorology

The following climatological data is from Climatography of the United States, No. 81 - Texas (United States Department of Commerce, National Climatic Center, Asheville, N.C., 1982) and Climatic Atlas of the United States (United States Department of Commerce, National Climatic Center, Asheville, N.C., 1979).

Data from the nearby Port Arthur Weather Station Office (41-7174) indicate that the Station has an average annual temperature of 68.7°F (29 year period, 1951-1980). The range was from a low of 51.9°F in January to a high of 83.1°F in July.

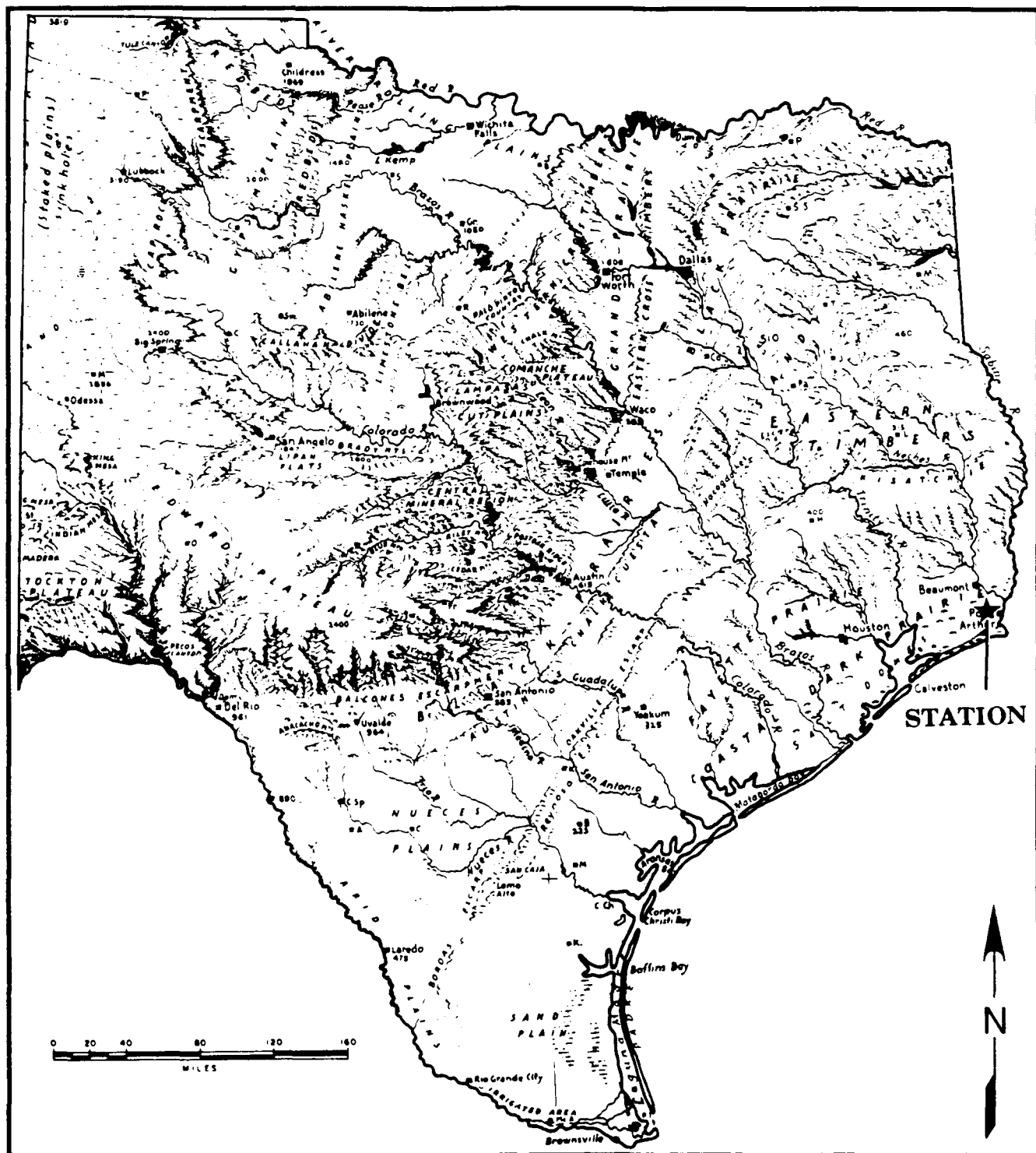
Average annual precipitation from 1951-1980 was 53.0 inches. Mean annual lake evaporation is 51 inches. Therefore, the net precipitation, calculated as the difference between the mean annual lake evaporation and average annual precipitation, is 2 inches per year. Maximum rainfall intensity, based on a 1-year, 24-hour rainfall, is 4.3 inches.

B. Geology

The Station is located in the Coastal Dark Prairie area, which is basically a flat featureless plain, 13 feet above mean sea level. Slopes of 1 foot per mile or less towards the Gulf are common (Figure II.1). In addition, the Station is located in the extreme southeast portion of Texas near the Texas-Louisiana state line, northwest of Port Arthur and Sabine Lake, in the Coastal Plain portion of the Gulf Coast Basin (Figure III.1).

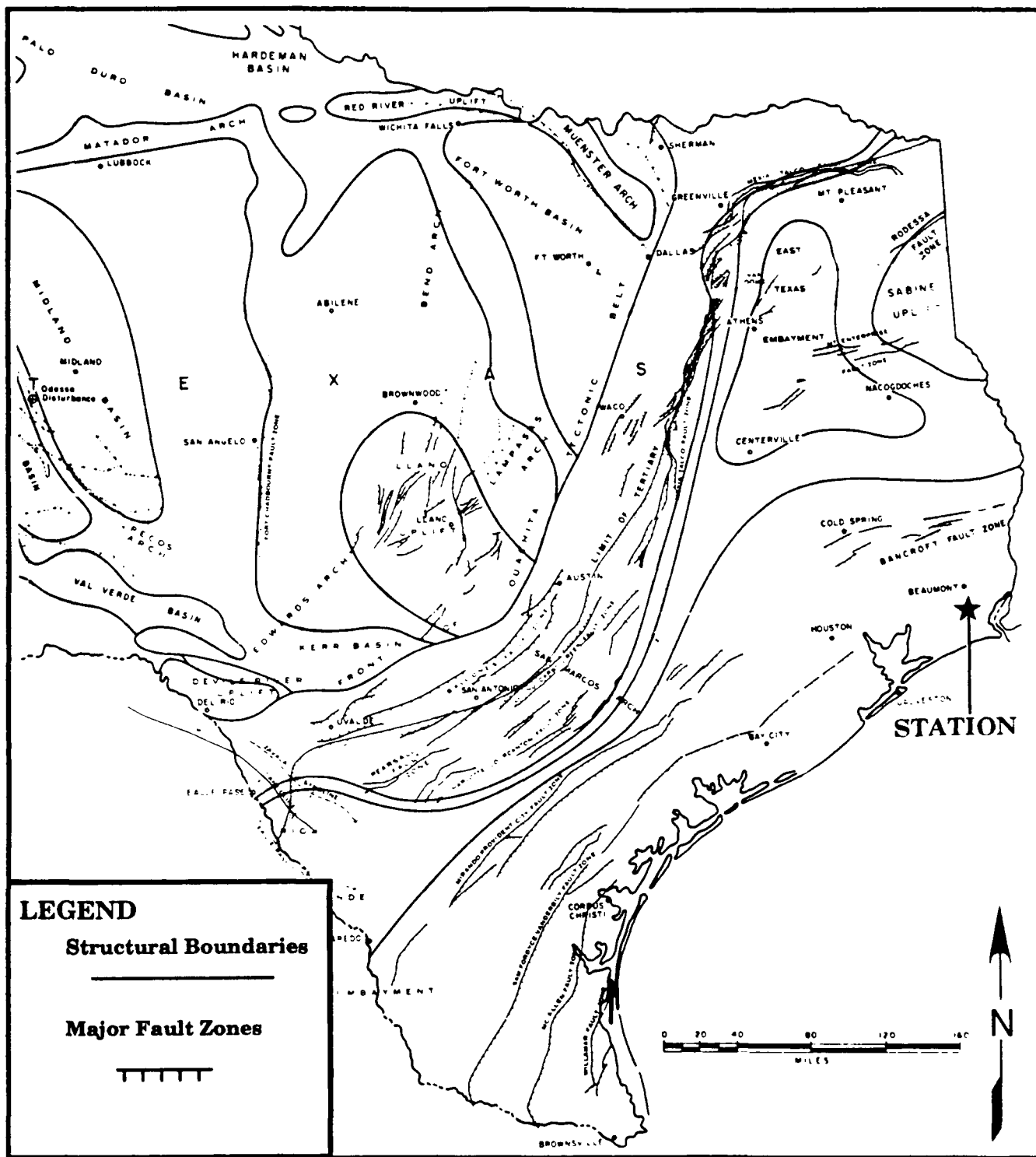
Carsey, 1950, and Waters, 1955, state that at the end of the Cretaceous Period, when the Gulf Coast Basin assumed its present outline, the northwestern portion, including Texas, began to emerge from the seas due to the subsidence in a seaward direction which formed an elongated basin in eastern and southern Texas. This basin was subparallel to the Gulf Coast Basin margins and received in excess of 50,000 feet of clastic sediments throughout the Cenozoic.

Cenozoic subbasins were formed as a result of differential subsidence associated with stable Paleozoic/Mesozoic positive features like the San Marcos Arch and the Sabine Uplift and Arch. In addition to receiving maximum sedimentation, these subbasins, such as the Texas Gulf Coast basin, were also the focal point for salt-related depositional and structural features (Figure III.2).



SOURCE: Geological Highway Map of TEXAS - by the American Association of Petroleum Geologists.

Figure III.1
Physiographic Map of Texas



SOURCE: Geological Highway Map of TEXAS - by the American Association of Petroleum Geologists.

Figure III.2
Tectonic Map of Texas

The Cenozoic history of the northwestern Gulf Coast Basin was characterized by a series of subparallel clastic, regressive depositional events interrupted and separated by deposition of alternating, transgressive marine shales (Waters, 1955; and Murray, 1961). The transgressive cycles are often accompanied by growth faults (down-to-the-coast). This depositional pattern produced thick wedges of progressively younger sediments in a gulfward direction. Metcalf, 1940, and Solis, 1981, described three distinctive physiographic zones in the Coastal Plain portion of southeast Texas: (1) an inland plain with rolling hills, up to 500 feet above mean sea level, dissected by the Sabine, Neches, Trinity, San Jacinto and Brazos Rivers; (2) a middle coastal plain with gentler hills and flatter topography with elevations up to 350 feet above mean sea level; and (3) a low coastal plain created essentially by Pleistocene and Recent sediments which form a flat fluvial and deltaic plain composed of flood basin muds cut extensively by meandering rivers and abandoned meanderbelt deposits. Elevations in the low coastal plain area range from sea level to approximately 100 feet above mean sea level.

The Station is underlain by sediments belonging to the Quaternary Beaumont Formation (Figure III.3). The Beaumont Formation consists principally of clays, silts, and sands that were deposited in meanderbelt, flood basin, levee, deltaic, barrier bar, and lagoon facies. Laterally as well as vertically, this formation interfingers with other Pleistocene sand and shale sequences that make up the Chicot aquifer. Furthermore, the Station is located in that part of the low coastal plain where the Beaumont Formation is mainly clay and mud of slow permeability, poor drainage, and high compressibility (Figure III.4). The Beaumont weathers into rich, dark soils crossed by meandering, low sand ridges. Clays are bluish gray and include calcareous nodules.

Like the Quaternary sediments, the Tertiary Pliocene and the Upper Miocene sediments are represented by the sand, gravel, silt, and clay that was built-up by rivers as coalescing fans on and near the continent and as marine and lagoonal deposits along the coast. The Pliocene includes sediments assigned to the Goliad Sand and the Upper Miocene includes the Fleming Formation.

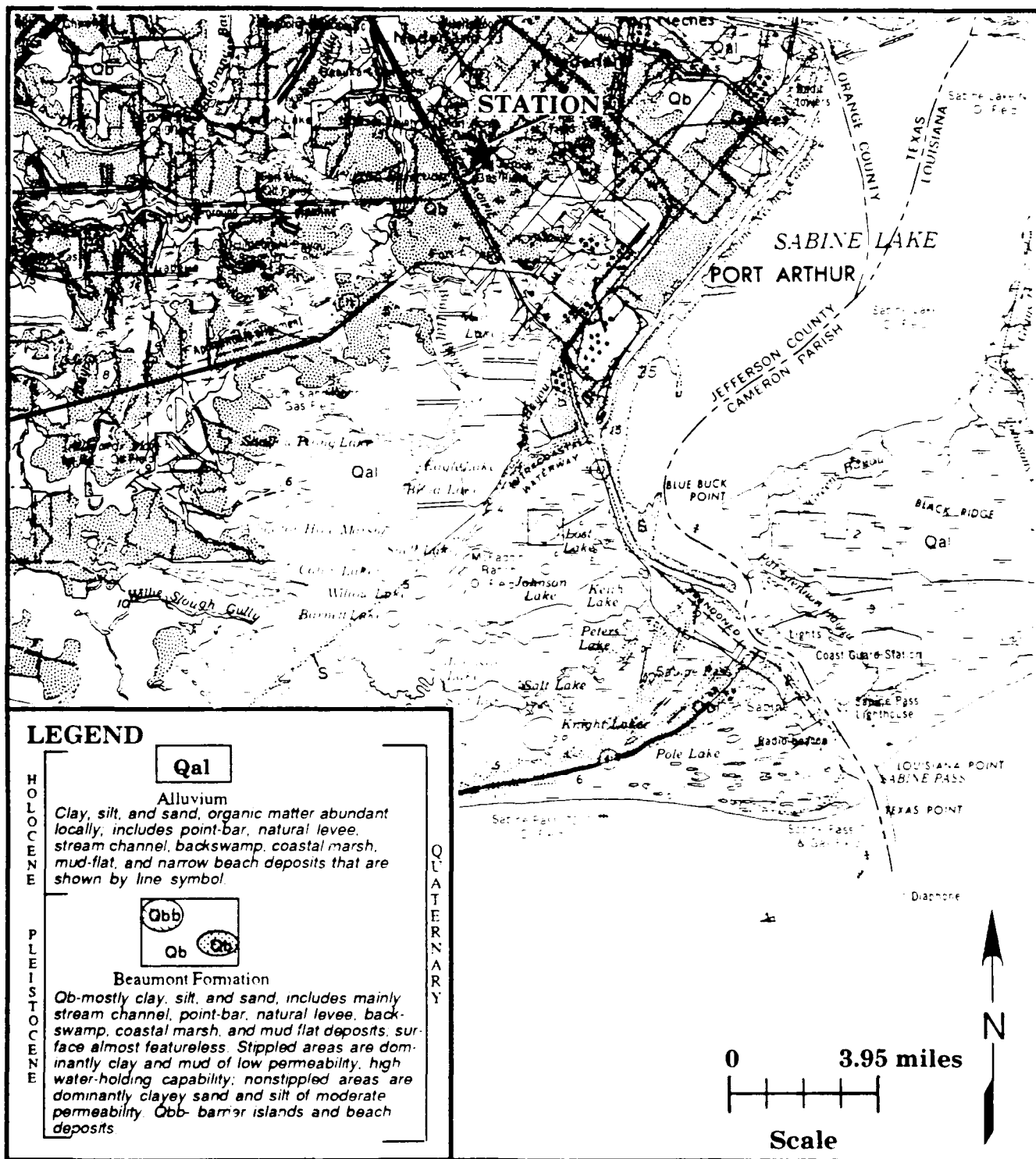
Soils beneath the Station represent a single soil association referred to as the Morey. The silty Morey soils are situated slightly higher topographically than the fine-textured, clayey Beaumont soils which are located south of the Station (Beaumont is used as a stratigraphic unit as well as a soil name). As a whole, the Morey association is nearly flat, and water stands for long periods after heavy rains.

The Morey silt loam soil unit occurs throughout the nearly level Coastal Prairie portion of Jefferson County. The surface layer is generally a gray to dark gray, acidic, silty loam which has an average thickness of 12 inches. Under cultivation, the surface layer loses organic matter rapidly and tends to become puddled when wet and very hard when dry. The subsoil is a gray, acid silty

Era	System	Series	Stratigraphic Units	Hydrogeologic Units	Remarks		
C E N O Z O I C	Quaternary	Holocene	Alluvium	Chicot aquifer	Quaternary System undifferentiated on sections.		
		Pleistocene	Beaumont Clay				
			Montgomery Formation				
			Bentley Formation				
			Willis Sand				
	Tertiary	Pliocene	Goliad Sand	Evangeline aquifer			
		Miocene	Fleming Formation	Burkeville confining system		Oakville Sandstone included in Fleming Formation east of Washington County.	
			Oakville Sandstone	Jasper aquifer	Cata- houla confining system (restricted)	Anahuac and "Frio" Formations may be Oligocene in age.	
			Catahoula Sandstone				Upper part of Catahoula Sandstone
							Anahuac Formation
							"Frio" Formation
			Pre-Miocene rocks				

SOURCE: Baker, E. T., Jr., Hydrology of the Jasper Aquifer in the Southeast Texas Coastal Plain, Texas Water Development Board, Report 295, 1986.

Figure III.3
Generalized Stratigraphic and Hydrologic
Column of the Southeast Texas Coastal Plain



SOURCE: Geologic Atlas of Texas, Houston Sheet

Figure III.4
Surficial Geologic Map of the Area

clay loam, and it has an average thickness of 24 inches. This unit is blocky, sticky when wet, and very hard when dry, which restricts the penetration of water, air, and plant roots. The Morey soils have very slow runoff and internal drainage. Permeability is slow (4.24×10^{-5} cm/sec to 1.41×10^{-4} cm/sec).

The Beaumont soil series, which adjoins the Station to the south, consists of gray to dark gray, poorly drained, acid soils that have more clay throughout their profile than the Morey series. Permeability is very slow (less than 4.24×10^{-5} cm/sec). The information pertaining to soils contained in the text was derived from the Soil Survey, Jefferson County, Texas (United States Department of Agriculture, Soil Conservation Service, 1965).

C. Hydrology

1. Surface Water

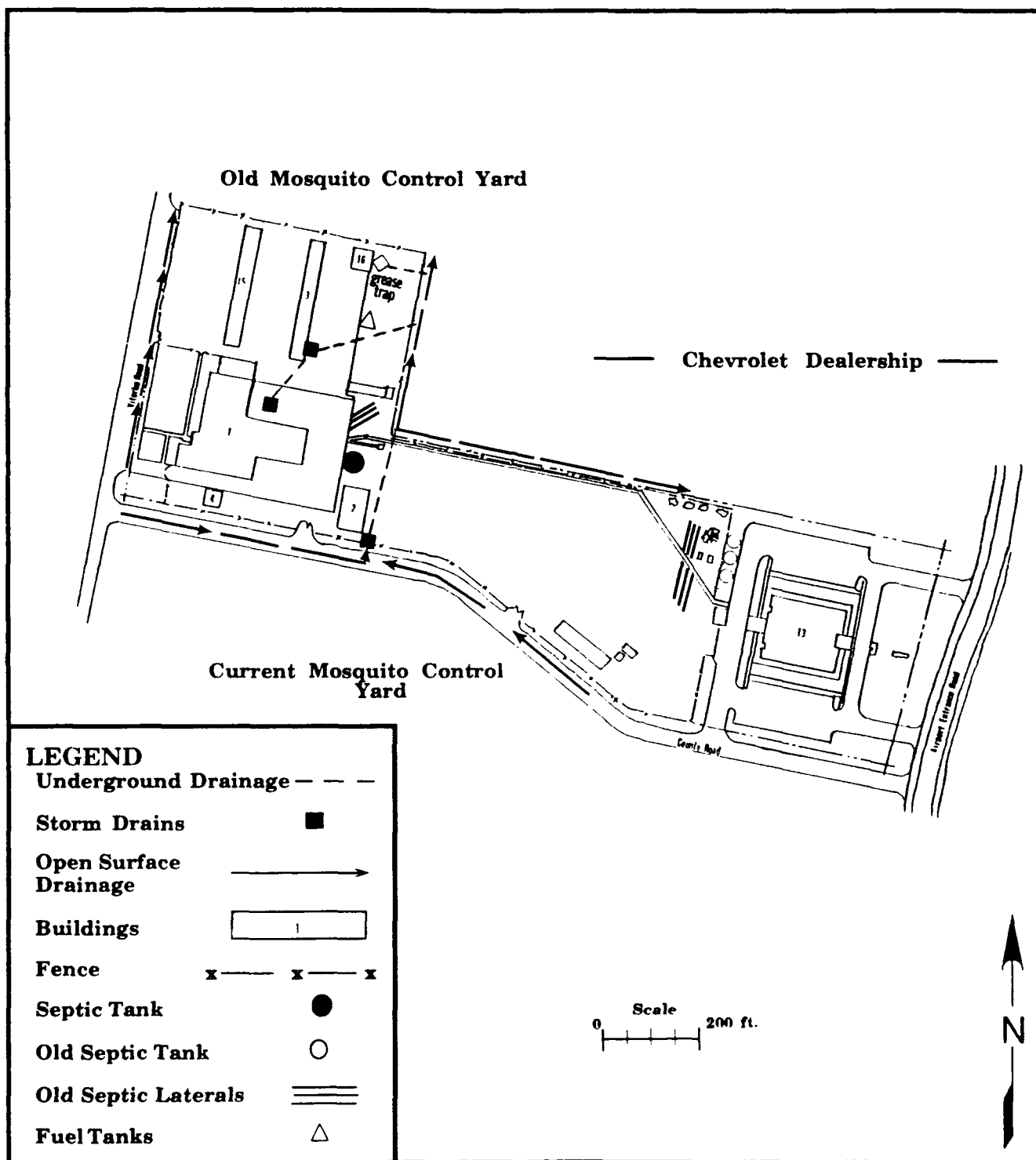
The Station is located in the Neches River/Intracoastal Waterway/Sabine Lake drainage basin. Surface runoff is through storm drains into open ditches that subsequently feed into the Intracoastal Waterway/Sabine Lake via Rhodair Gully and Big Hill Reservoir. (Figure III.5). The Station has been classified as being outside the 100-year flood plain.

2. Groundwater

All of the groundwater in the vicinity of the Station exists under confined conditions beneath the sand-poor Beaumont aquitard. Groundwater is contained mostly within sands of Tertiary Pliocene and Quaternary Pleistocene ages. These aquifers are, from youngest to oldest: Chicot, Evangeline, and Jasper (Baker, 1986). These southeast Texas coastal aquifers are typical Gulf coast aquifers in that they are three-dimensional sedimentary wedges that have a large sand-to-clay ratio (Figure III.6).

Historically, the Chicot aquifer includes all of the Quaternary Pleistocene stratigraphic units, and, at one time, it served as the main source of groundwater in Jefferson and Orange counties prior to the development of major surface water sources. In the vicinity of the coastline, the Chicot aquifer attains a thickness of approximately 1200 feet (Figure III.6).

The base of the Chicot aquifer has an elevation of 900 feet below mean sea level in the vicinity of the Station and consists of a basal sand unit referred to as the Willis Formation. Overall, the Chicot displays a large hydraulic conductivity (as much as 75 feet/day). Figure III.7 shows that in the spring of 1987, the Chicot had a water level altitude of approximately 20 feet below

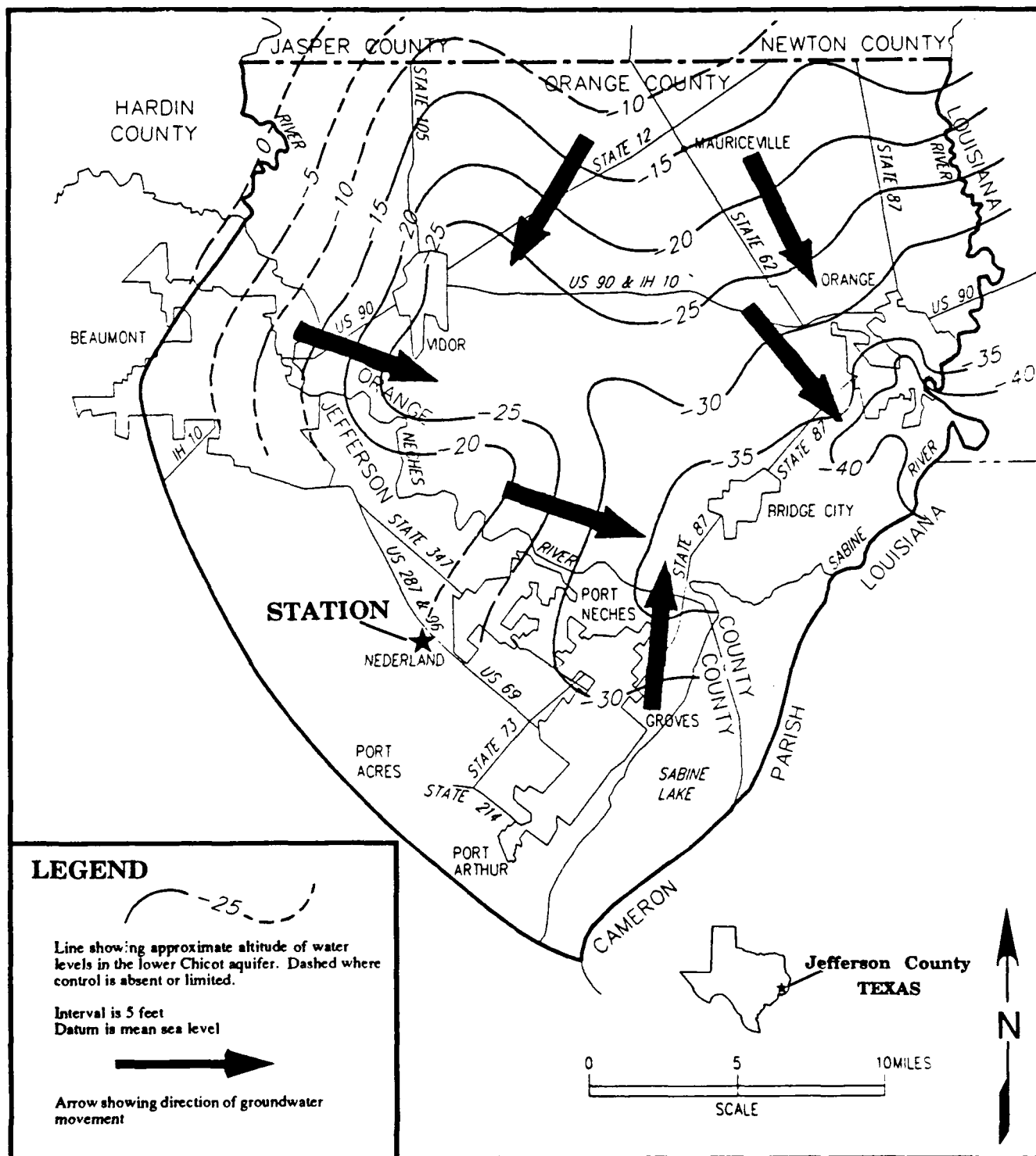


SOURCE: Nederland ANG Station Site Plan.

Figure III.5
Drainage Map of
the Nederland Air National Guard Station



Stratigraphic and Hydrologic Section of the Area



SOURCE: Thorkildsen, D. and R. Quincy. Evaluation of Water Resources of Orange and Eastern Jefferson Counties, Texas Water Development Board, Report 320, 1990.

Figure III.7
Approximate Altitude of Water Levels
in the Lower Chicot Aquifer, Spring 1987

mean sea level. Water level fluctuations were in the range of 0 to 5 feet during the ten-year period of 1977 to 1987 (Thorkildsen, 1990).

Immediately below the Chicot aquifer, and sometimes without any apparent lithologic separation, the Evangeline aquifer is present. This Pliocene age aquifer generally has a lower hydraulic conductivity as well as a different water level than the shallower Chicot (Figure III.6). The Evangeline aquifer has not been considered a major groundwater source in southern Jefferson and Orange counties because of its saline character. In the outcrop area, the Evangeline ranges in thickness from approximately 400 to 600 feet. Near the coastline, its thickness is approximately 2300 feet.

The Upper Miocene Jasper aquifer, which underlies the Chicot and Evangeline, is not used for groundwater in southern Jefferson and Orange counties because of its saline nature. However, north of Beaumont, in an arcuate belt that is subparallel to the coastline, large volumes of fresh groundwater are extracted from the upslope portions of the Jasper.

Regional as well as local variations in sand thickness and fresh-saline water interface occur because of the effect of growth faulting (down-to-the-coast). In the vicinity of the Station, faulting does not appear to play a significant role.

Subsidence due to groundwater and/or petroleum withdrawal has been minimal (approximately 1 foot) during the ten-year period of 1977 to 1987.

Seasonal variations in the low coastal plain cause the water table to vary from 2 to 3 feet below ground elevation to as much as 13 to 17 feet below ground surface.

D. Critical Habitats/Endangered or Threatened Species

According to records maintained by the Texas Parks and Wildlife Department, no endangered or threatened species of flora or fauna have been identified within a 1-mile radius of the Station.

IV. SITE EVALUATION

A. Activity Review

A review of Station records and interviews with personnel were used to identify specific operations in which the majority of hazardous materials and/or hazardous wastes are used, stored, disposed of, and processed. Table IV.1 provides a history of waste generation and disposal for operations conducted by the Vehicle Maintenance Shop at the Station. This Shop also performs maintenance on AGE equipment when necessary. If an item is not listed on the table on a best-estimated basis, that activity or operation produces negligible (less than 1 gallon/year) waste requiring disposal.

Fresh product diesel fuel is stored in a 500-gallon, skid-mounted, aboveground tank while gasoline is stored in a 2000-gallon, underground storage tank just southeast of Building 3. The 273rd EIS generates hazardous wastes primarily through vehicle and AGE maintenance operations. Over the years, these wastes have been collected and stored until disposed of by a contractor.

The potable water supply for the Station has been provided by the city of Nederland since the late 1980s. Prior to that time, water was supplied by the Jefferson County Airport. An abandoned water well is located at the northeast corner of Building 1. This well provided water for an air conditioning unit and was not used for drinking water. In addition, the well was taken out of service in the late 1960s when it was capped and covered with concrete during construction of the driveway and parking lot.

The Station was connected to the sanitary sewer service in the late 1970s. This service is provided by the city of Nederland. Prior to this, the Station used a septic field system. Only the bathroom facilities and a sink in the Vehicle Maintenance Shop (Building 1) and Headquarters (Building 13) were connected to the septic system. The washrack and the floor drains in the shops empty into the storm sewer. However, a project has been planned to install an oil/water separator that will be connected to these facilities. This separator will be connected to the sanitary sewer.

B. Disposal/Spill Site Information, Evaluation, and Hazard Assessment

Six persons were interviewed to identify and locate potential sites that may have been contaminated by hazardous wastes as a result of past Station operations. One potentially contaminated site was identified through the interviews. This site identification was followed by a visual field examination of the site. This site was rated by application of the United States Air Force (USAF) HARM, and since the potential for contaminant migration exists it is recommended for further investigation under the IRP program.

Table IV.1

**Hazardous Materials/Hazardous Wastes Disposal Summary: Nederland Air
National Guard Station, Nederland, Texas.**

Shop Name and Location	Possible Hazardous Wastes	Estimated Quantities (Gallons/Year)	1957	1965	1975	1985	1990
Vehicle Maintenance (Bldg. 1)	Engine Oil	200			CONTR		
	Battery Acid	10			CONTR		
	Ethylene Glycol	50		STORM/CONTR		CONTR	
	Transmission Fluid	20			CONTR		
	Paint Thinner	10		TRASH/CONTR		CONTR	
	Polyurethane	10		TRASH/CONTR		CONTR	
	Enamel	10		TRASH/CONTR		CONTR	
	Zinc Chromate Primer	20		TRASH/CONTR		CONTR	
	Parts Cleaner	50		CONTR		NLU	
	Safety Kleen	200		NIU		CONTR	
	Methyl Ethyl Ketone	20		TRASH		NLU	
	Naphtha	10		TRASH/CONTR		CONTR	

KEY:

- CONTR - Disposed of through a Contractor.
- NIU - Material not in use at this time.
- NLU - Material is no longer used at the Station.
- STORM - Disposed of down drains leading to the storm sewer.
- TRASH - Disposed of in trash (i.e. residual in cans, on rags, etc.).

* From 1980 until 1985, liquid wastes were dumped into an underground tank. A contractor periodically pumped the tank and disposed of the liquid wastes.

Copies of completed HARM forms and an explanation of the factor rating criteria used for site scoring are contained in Appendix C.

The potential exists for contaminant migration at the rated site. Contaminants that may have been released have the potential to be transported by groundwater and surface water. The water table is less than 10 feet below the ground surface at the Station. If the shallow groundwater becomes contaminated by hazardous wastes, then, under certain circumstances, the deeper aquifers may also be contaminated by groundwater migration.

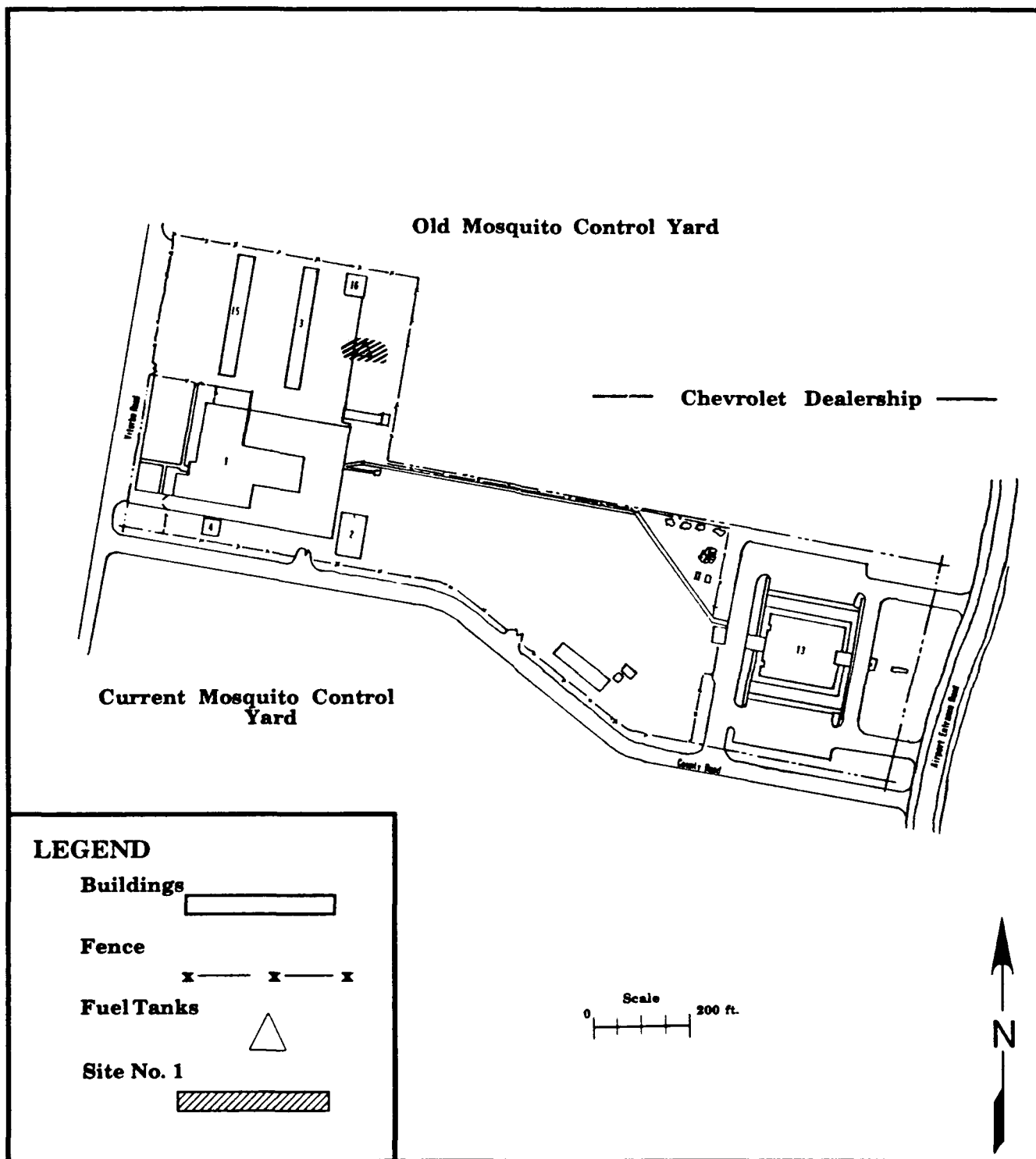
The location of the identified site is shown on Figure IV.1. A description of the potential site identified at the Station follows.

Site No. 1 - Underground Storage Tank at Building 3 (HAS - 63)

An abandoned underground storage tank (UST) is located approximately 50 feet southeast of the Vehicle Parking Shed (Building 3). This area is the site of the original fuel island. The original gas pump is still in place; however, it is presently connected to a fiberglass tank that was installed in 1980. According to property records, the abandoned tank had been installed in 1963.

This 2000-gallon steel tank contained automotive gasoline (MOGAS) and was abandoned in 1980 because inventory checks revealed that water was infiltrating the tank. From approximately 1980 until 1985, the abandoned MOGAS tank was used to store liquid wastes including oils, solvents, thinners, and fuels generated by maintenance operations. A contractor periodically pumped liquid wastes out of the tank and disposed of them. The tank was last pumped dry in 1985 and has not been used since that time. Since a potential for soil and groundwater contamination exists, a HAS was calculated for this potential site.

Although inventory checks revealed that water was entering the tank, it is not known if any fuel or waste material had been released from the tank. Because no exact quantities, if any, are known to have been released in the area, a small quantity has been assigned to this potential site. According to HARM, a small quantity is less than 20 drums (1100 gallons). In addition, because of the nature of the solvents disposed, a high hazard rating will be assigned to this potential site.



SOURCE: Nederland ANG Station Site Plan.

Figure IV.1
Potential Sites
at the Nederland Air National Guard Station

C. Other Pertinent Facts

- o Trash and nonhazardous solid wastes are disposed of by the city of Nederland.
- o Transformers at the Station belong to the Gulf States Utility Company.
- o There is an abandoned hydraulic lift in the Vehicle Maintenance Shop (Building 1). It was abandoned in the middle 1970s, and the pit was filled with sand.
- o Stressed vegetation is present along the laterals of the old septic system near the Vehicle Maintenance Shop. From 1957 until the late 1970s, the bathroom facilities and a sink in the Vehicle Maintenance Shop were connected to this system. However, interviewees reported that hazardous materials were never poured down drains leading to the septic system.
- o Adjacent to the Station's property is the Jefferson County Mosquito Control company. This organization provides a large portion of pest and weed control for Jefferson County. Interviewees reported that this company handled large volumes of herbicides and pesticides. Reports also indicated that numerous drums of such materials were stored just across the boundary fence at the northeast side of the Station. It is not known if these drums leaked or if there were any spills. However, materials were often mixed and sprayed along the Station's fences and along fence lines that ran across Air National Guard property.

The mosquito control company was present northeast of the Station property before the Air National Guard occupied the land. During the late 1980s, Jefferson County Mosquito Control built and moved into a new facility just across the southwest boundary fence. The company continues to occupy the site at this time. The original site of Jefferson County Mosquito Control is presently occupied by a state and county highway maintenance organization.

- o There is a Chevrolet dealership located adjacent to Station property just across the northeast boundary. It has been present since 1986. The automobile wash area for this dealership drains towards the Station property and then drains southeast as it reaches the fence line. A short concrete drainage ditch runs parallel to the boundary fence and carries this drainage to a grassy area adjacent to the abandoned septic system behind the Station Headquarters (Building 13).

V. CONCLUSIONS

Information obtained through interviews with six present and past Station personnel, reviews of Station records, and field observations resulted in the identification of one potentially contaminated disposal and/or spill site on Station property. This potential site is as follows:

Site No. 1 - Underground Storage Tank at Building 3 (HAS - 63)

This site exhibits the potential for contaminant migration into shallow groundwater.

VI. RECOMMENDATIONS

The PA identified one potentially contaminated site. As a result, additional investigation under the IRP is recommended for this site to confirm the presence or absence of contamination.

BIBLIOGRAPHY

- Baker, E. T., Jr. Hydrology of the Jasper Aquifer in the Southeast Texas Coastal Plain. Texas Water Development Board, Report 295, 1986.
- Barbie, D. L. et al. Approximate Altitude of Water Levels in Wells in the Chicot and Evangeline Aquifers in the Houston Area, Texas, Spring 1989. United States Geological Survey, Open-File Report 89-237, 1989.
- Barton, D. C. Surface Geology of Coastal Southeastern Texas. American Association of Petroleum Geologists Bulletin, v. 14, No. 10, p. 1301-1320, 1930.
- Bernard, H. A. et al. Recent and Pleistocene Geology of Southeast Texas. Houston Geological Society Guidebook, p. 175-224, 1962.
- Carsey, J. B. Geology of the Gulf Coastal and Continental Shelf. American Association of Petroleum Geologists Bulletin, v. 34, No. 3, p. 361-385, 1950.
- Doering, J. A. Review of Quaternary Surface Formation of Gulf Coast Regions. American Association of Petroleum Geologists Bulletin, v. 40, No. 8, p. 1816-1862, 1956.
- Fisher, W. L. et al. Environmental Geologic Atlas of the Texas Coastal Zone - Galveston/Houston Area. The University of Texas at Austin, Bureau of Economic Geology, 1972.
- Fisher, W. L. et al. Environmental Geologic Atlas of the Texas Coastal Zone - Beaumont/Port Arthur Area. The University of Texas at Austin, Bureau of Economic Geology, 1973.
- Gabrysch, R. K. and C. W. Bonnet. Land-Surface Subsidence at Seabrook, Texas. United States Geological Survey, Water-Resources Investigation 76-31, 1975.
- Gabrysch, R. K. Ground Water Withdrawals and Land-Surface Subsidence in the Houston-Galveston Region, Texas, 1906-1980. Texas Department of Water Resources, Report 287, 1984.
- Geologic Atlas of Texas, Houston Sheet. The University of Texas at Austin, 1982.
- Hammond, W. W. Groundwater Resources of Matagorda County, Texas. Texas Water Development Board, Report 91, 1969.
- Metcalf, R. J. Deposition of Lissie and Beaumont Formations of the Gulf Coast of Texas. American Association of Petroleum Geologists Bulletin, v. 24, No. 4, p. 693-700, 1940.

BIBLIOGRAPHY (continued)

- Murray, G. P. Geology of the Atlantic and Gulf Coastal Province of North America. New York, Harper Geoscience Series, 1961.
- Paine, J. G. and R. A. Morton. Historical Shoreline Changes in Trinity, Galveston, West and East Bays, Texas Gulf Coast. Bureau of Economic Geology, University of Texas at Austin, Geological Circular 86-3, 1986.
- Solis, R. F. Upper Tertiary and Quaternary Depositional Systems, Central Coastal Plain, Texas - Regional Geology of the Coastal Aquifer and Potential Liquid-Waste Repositories. Bureau of Economic Geology, The University of Texas at Austin, Report of Investigations No. 108, 1981.
- St. Clair, A. E. et al. Land and Water Resources - Houston/Galveston Area Council. Laboratory Map Series, Bureau of Economic Geology, The University of Texas at Austin, 1975.
- Thorkildsen, D. and R. Quincy. Evaluation of Water Resources of Orange and Jefferson Counties, Texas. Texas Water Development Board, Report 320, 1990.
- United States Department of Agriculture, Soil Conservation Service. Soil Survey, Jefferson County, Texas. 1965.
- United States Department of Agriculture, Soil Conservation Service. Soil Survey of Harris County, Texas. 1976.
- United States Department of Commerce. Climatic Atlas of the United States. National Oceanic and Atmospheric Administration, Environmental Data and Information Service, National Climatic Center, 1979.
- United States Department of Commerce. Climatology of the United States, No. 81 - Texas; Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1951-1980. National Oceanic and Atmospheric Administration, Environmental Data and Information Service, National Climatic Center, 1982.
- Waters, J. A. Geological Framework of Gulf Coastal Plain of Texas. American Association of Petroleum Geologists Bulletin, v. 39, No. 9, p. 1821-1850, 1955.
- Wood, L. A. et al. Reconnaissance Investigations of the Ground Water Resources of the Gulf Coastal Region, Texas. Texas Water Commission, Bulletin 6305, 1963.

GLOSSARY OF TERMS

ALLUVIAL - Pertaining to or composed of alluvium or deposited by a stream or running water.

ALLUVIAL FAN - An outspread, gently sloping mass of alluvium deposited by a stream, especially in an arid or semiarid region where a stream issues from a narrow canyon onto a plain or valley floor.

ANNUAL PRECIPITATION - The total amount of rainfall and snowfall for the year.

AQUIFER - A water-bearing layer of rock that will yield water in a usable quantity to a well or spring.

AQUITARD - A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer.

ARGILLACEOUS - Like or containing clay.

BASIN - (a) A depressed area with no surface outlet; (b) A drainage basin or river basin; (c) A low area in the Earth's crust, of tectonic origin, in which sediments have accumulated.

BAY - A wide, curving open indentation, recess, or inlet of a sea or lake into the land or between two capes or headlands, larger than a cove, and usually smaller than, but of the same general character as a gulf.

BED [stratig] - The smallest formal unit in the hierarchy of lithostratigraphic units. In a stratified sequence of rocks it is distinguishable from layers above and below. A bed commonly ranges in thickness from a centimeter to a few meters.

BEDDING [stratig] - The arrangement of sedimentary rock in beds or layers of varying thickness and character.

BEDROCK - A general term for the consolidated (solid) rock that underlies soil or other unconsolidated superficial material. See **HORIZON [soil]** - *R layer*.

CLASTIC - Rock or sediment composed principally of fragments derived from pre-existing rocks or minerals and transported some distance from their place of origin.

CLAY [soil] - A rock or mineral particle in the soil having a diameter less than 0.002 mm (2 microns).

CLAY [geol] - A rock or mineral fragment or a detrital particle of any composition smaller than a fine silt grain, having a diameter less than 1/256 mm (4 microns).

COARSE-TEXTURED (light textured) SOIL - Sand or loamy sand.

COMPRESSIBILITY - The change of volume and density under hydrostatic pressure.

CONE OF DEPRESSION - The depression of heads around a pumping well caused by the withdrawal of water.

CONGLOMERATE - A coarse-grained sedimentary rock, composed of rounded pebbles, cobbles, and boulders, set in a fine-grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay.

CONSOLIDATION - Any process whereby loosely aggregated, soft, or liquid earth materials become firm and coherent rock; specif. the solidification of a magma to form an igneous rock, or the lithification of loose sediments to form a sedimentary rock.

CONTAMINANT - As defined by Section 101(f)(33) of Superfund Amendments and Reauthorization Act of 1986 (SARA) shall include, but not be limited to any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformation in such organisms or their offspring; except that the term "contaminant" shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under:

- (a) any substance designated pursuant to Section 311(b)(2)(A) of the Federal Water Pollution Control Act,
- (b) any element, compound, mixture, solution, or substance designated pursuant to Section 102 of this Act,
- (c) any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the Solid Waste Disposal Act (but not including any waste the regulation of which under

the Solid Waste Disposal Act has been suspended by Act of Congress),

- (d) any toxic pollutant listed under Section 307(a) of the Federal Water Pollution Control Act,
- (e) any hazardous air pollutant listed under Section 112 of the Clean Air Act, and
- (f) any imminently hazardous chemical substance or mixture with respect to which the administrator has taken action pursuant to Section 7 of the Toxic Substance Control Act;

and shall not include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas).

CONTEMPORANEOUS FAULT - See GROWTH FAULT.

CREEK - A term generally applied to any natural stream of water, normally larger than a brook but smaller than a river.

CRITICAL HABITAT - The specific areas within the geographical area occupied by the species on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management consideration or protection.

DEPOSITS - Earth material of any type, either consolidated or unconsolidated, that has accumulated by some natural process or agent.

DRAINAGE CLASS (natural) - Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained - Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained - Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well-drained - Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does

not inhibit growth of roots for significant periods during most growing seasons. Well-drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained - Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained - Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained - Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough periods during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained - Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

DRAINAGEWAY - A channel or course along which water moves in draining an area.

DRAWDOWN - The reduction in head at a point caused by the withdrawal of water from an aquifer.

EMBAYMENT - A downwarped region of stratified rocks that extends into a region of other rocks.

ENDANGERED SPECIES - Any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the Class Insecta determined by the secretary to constitute a pest whose protection would present an overwhelming and overriding risk to man.

EROSION - The general process or the group of processes whereby the materials of the Earth's crust are loosened, dissolved, or worn away, and simultaneously moved from one place to another by natural agencies, but usually exclude mass wasting.

FAULT - A fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.

FINE-GRAINED - Said of a soil in which silt and/or clay predominate.

FINE-TEXTURED (heavy textured) SOIL - Sandy clay, silty clay, and clay.

FLOOD PLAIN - The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regimen and covered with water when the river overflows its banks.

FOLD [geol struc] - A curve or bend of a planar structure such as rock strata, bedding planes, foliation or cleavage.

FORMATION - A lithologically distinctive, mappable body of rock.

FRACTURE [struc geol] - A general term for any break in a rock, whether or not it causes displacement, due to mechanical failure by stress. Fracture includes cracks, joints, and faults.

GEOLOGIC TIME - See Figure G1.1.

GRANITE - Broadly applied, any crystalline, quartz-bearing plutonic rock; also commonly contains feldspar, mica, hornblende, or pyroxene.

GRAVEL - An unconsolidated, natural accumulation of rounded rock fragments resulting from erosion, consisting predominantly of particles larger than sand, such as boulders, cobbles, pebbles, granules or any combination of these fragments.

GROUNDWATER - Water in the saturated zone that is under a pressure equal to or greater than atmospheric pressure.

GROWTH FAULT - A fault in sedimentary rock that forms contemporaneously and continuously with deposition, so that the displacement (throw) increases with depth and the strata of the downthrown side are thicker than the correlative strata of the upthrown side.

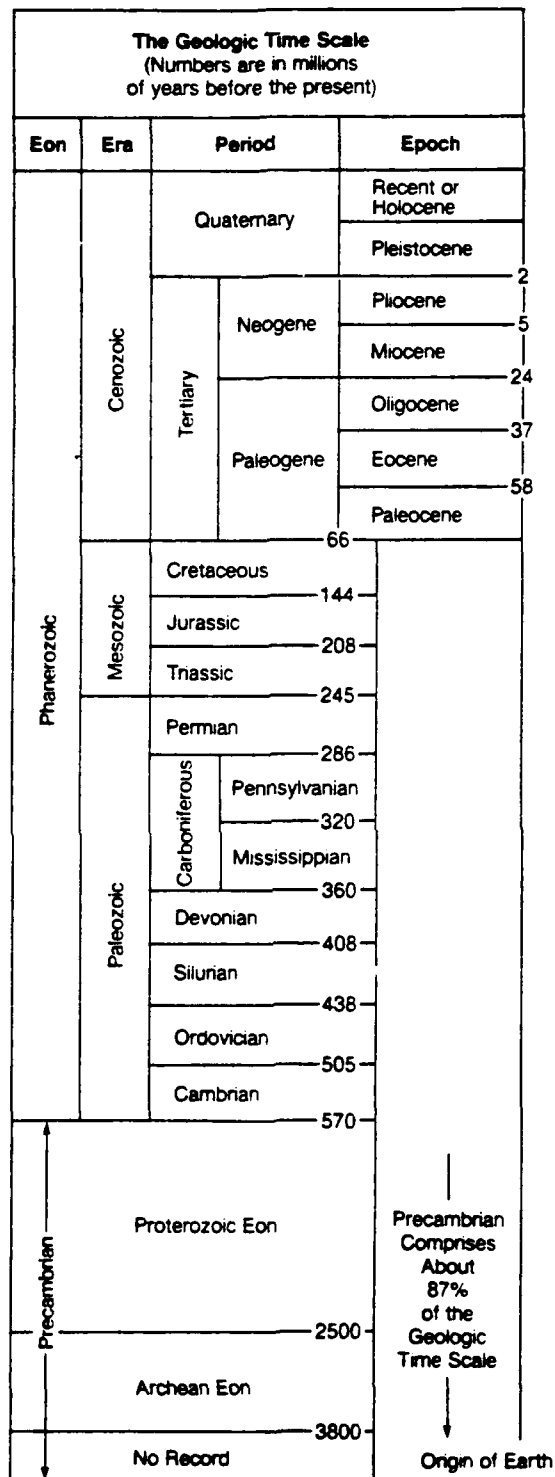


Figure G1.1

The Geologic Time Scale

HARM - Hazard Assessment Rating Methodology - A system adopted and used by the United States Air Force to develop and maintain a priority listing of potentially contaminated sites on installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts. (Reference: DEQPPM 81-5, December 11, 1981.)

HAS - Hazard Assessment Score - The score developed by using the Hazard Assessment Rating Methodology (HARM).

HAZARDOUS MATERIAL - Any substance or mixture of substances having properties capable of producing adverse effects on the health and safety of the human being. Specific regulatory definitions also found in OSHA and DOT rules.

HAZARDOUS WASTE - A solid or liquid waste that, because of its quantity, concentration, or physical, chemical, or infectious characteristics may:

- a. cause, or significantly contribute to, an increase in mortality or an increase in serious or incapacitating reversible illness, or
- b. pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

HEAD - See TOTAL HEAD.

HERBICIDE - A weed killer.

HIGHLAND - A general term for a relatively large area of elevated or mountainous land standing prominently above adjacent low areas; and mountainous region.

HILL - A natural elevation of the land surface, rising rather prominently above the surrounding land, usually of limited extent and having a well-defined outline (rounded) and generally considered to be less than 1000 feet from base to summit.

HORIZON [soil] - A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon - An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon - The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral

material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon - A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon - The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon - The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer - Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

HYDRAULIC CONDUCTIVITY - The rate of flow of water in gallons per day through a cross section of one square foot under a unit hydraulic gradient, at the prevailing temperature or adjusted for a temperature of 60°F

IGNEOUS ROCKS - Rock or mineral that has solidified from molten or partially molten material, i.e. from magma.

INTERBEDDED - Beds lying between or alternating with others of different character; especially rock material laid down in sequence between other beds.

LOAM - A rich, permeable soil composed of a friable mixture of relatively equal proportions of sand, silt, and clay particles, and usually containing organic matter.

LOWLAND - A general term for low-lying land or an extensive region of low land, esp. near the coast and including the extended plains or country lying not far above tide level.

MEANDERBELT - The zone along a valley floor across which a meandering stream shifts its channel from time to time.

MEAN LAKE EVAPORATION - The total evaporation amount for a particular area; amount based on precipitation and climate (humidity).

MEAN SEA LEVEL - The average height of the surface of the sea for all stages of the tide over a 19-year period.

METAMORPHIC ROCK - Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes, essentially in solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the Earth's crust.

MIGRATION (Contaminant) - The movement of contaminants through pathways (groundwater, surface water, soil, and air).

MINERAL - A naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form and physical properties.

MONTMORILLONITE - A clay mineral of the smectite group comprising expanding-lattice clay minerals when wetted.

MOTTLED [soil] - a soil that is irregularly marked with spots or patches of different colors, usually indicating poor aeration or seasonal wetness.

NET PRECIPITATION - Precipitation minus evaporation.

OUTCROP - That part of a geologic formation or structure that appears at the surface of the Earth; also, bedrock that is covered only by surficial deposits such as alluvium.

OVERTURNED - Said of a fold or the limb of a fold, that has tilted beyond the perpendicular. Sequence of strata thus appears reversed.

PD-680 - A cleaning solvent composed predominately of mineral spirits; Stoddard solvent.

PERMEABILITY - The capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure - see **SOIL PERMEABILITY**.

POND - A natural body of standing fresh water occupying a small surface depression, usually smaller than a lake and larger than a pool.

POROSITY - The voids or openings in a rock. Porosity may be expressed quantitatively as the ratio of the volume of openings in a rock to the total volume of the rock.

POTENTIOMETRIC SURFACE - A surface that represents the total head in an aquifer; that is, it represents the height above a datum plane at which the water level stands in tightly cased wells that penetrate the aquifer.

PROGRADE - To build outward towards the sea by deposition of sediment.

QUARTZ - A crystalline silica, an important rock forming mineral: SiO_2 . Occurs either in transparent hexagonal crystals (colorless or colored by impurities) or in crystalline or cryptocrystalline masses. Forms the major proportion of most sands and has a widespread distribution in igneous, metamorphic and sedimentary rocks.

RIFT - A long, narrow continental trough bounded by normal faults.

RIVER - A general term for a natural freshwater surface stream of considerable volume and a permanent or seasonal flow, moving in a definite channel toward a sea, lake, or another river.

SALINE [adj] - Salty; containing dissolved sodium chloride.

SAND - A rock or mineral particle in the soil, having a diameter in the range 0.52 - 2 mm.

SANDSTONE - A medium-grained fragmented sedimentary rock composed of abundant round or angular fragments of sand, size set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material (commonly silica, iron oxide, or calcium carbonate).

SANDY LOAM - A soil containing 43 - 85% sand, 0 - 50% silt, and 0 - 20% clay, or containing at least 52% sand and no more than 20% clay and having the percentage of silt plus twice the percentage of clay exceeding 30% or containing 43 - 52% sand, less than 50% silt, and less than 7% clay.

SATURATED ZONE - The subsurface zone in which all openings are full of water.

SEDIMENT - Solid fragmental material that originates from weathering of rocks and is transported or deposited by air, water, or ice, or that accumulates by other natural agents, such as chemical precipitation from solution or secretion by organisms, and that forms in layers on the Earth's surface at ordinary temperatures in a loose, unconsolidated form; (b) strictly solid material that has settled down from a state of suspension in a liquid.

SEDIMENTARY ROCK - A rock resulting in the consolidation of loose sediment that has accumulated in layers; e.g., a clastic rock (such as conglomerate or tillite) consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice; or a chemical rock (such as rock salt or gypsum) formed by precipitation from solution; or an organic rock (such as certain limestones) consisting of the remains or secretions of plants and animals.

SHALE - A fine-grained detrital sedimentary rock, formed by the consolidation (especially by compression) of clay, silt, or mud.

SILT [soil] - (a) A rock or mineral particle in the soil, having a diameter in the range 0.002-0.005 mm; (b) A soil containing more than 80% silt-size particles, less than 12% clay, and less than 20% sand.

SILT LOAM - A soil containing 50 - 88% silt, 0 - 27% clay and 0 - 50% sand.

SLICKENSIDE - A polished and striated rock surface that results from friction along a fault plane.

SOIL - The layer of material at the land surface that supports plant growth.

SOIL PERMEABILITY - The characteristic of the soil that enables water to move downward through the profile. Permeability is measured as the distance per unit time that water moves downward through the saturated soil.

Terms describing permeability are:

Very Slow	-	less than 0.06 inches per hour (less than 4.24×10^{-5} cm/sec)
Slow	-	0.06 to 0.20 inches per hour (4.24×10^{-5} to 1.41×10^{-4} cm/sec)
Moderately Slow	-	0.20 to 0.63 inches per hour (1.41×10^{-4} to 4.45×10^{-4} cm/sec)
Moderate	-	0.63 to 2.00 inches per hour (4.45×10^{-4} to 1.41×10^{-3} cm/sec)
Moderately Rapid	-	2.00 to 6.00 inches per hour (1.41×10^{-3} to 4.24×10^{-3} cm/sec)
Rapid	-	6.00 to 20.00 inches per hour (4.24×10^{-3} to 1.41×10^{-2} cm/sec)

Very Rapid - more than 20.00 inches per hour (more than 1.41×10^{-2} cm/sec)

(Reference: United States Department of Agriculture, Soil Conservation Service)

SOIL REACTION - The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests at pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as:

pH

Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

SOIL STRUCTURE - See STRUCTURE [soil].

SOLUM - The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum. See HORIZON [soil].

SOLVENT - A substance, generally a liquid, capable of dissolving other substances.

STRAND PLAIN - A prograded shore built seaward by waves and currents, and continuous for some distance along the coast.

STRATIFIED - Formed, arranged, or laid down in layers or strata; especially said of any layered sedimentary rock or deposit.

STRIKE - SLIP FAULT - A fault on which the movement is parallel to the fault's strike. See TRANSCURRENT FAULT.

STRUCTURE [soil] - The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are - platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

SUBSOIL - Technically, the B horizon; roughly, the part of the solum below plow depth.

SUBSTRATUM - The part of the soil below the solum.

SURFACE WATER - All water exposed at the ground surface, including streams, rivers, ponds, and lakes.

SYNCLINORIUM - A composite synclinal structure of regional extent composed of lesser folds.

TERRACE [geomorph] - Any long, narrow, relatively level or gently inclined surface, generally less broad than a plain, bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope.

TERRACE [soil] - A horizontal or gently sloping ridge or embankment of earth built along the contours of a hillside for the purpose of conserving moisture, reducing erosion, or controlling runoff.

TERRIGENOUS DEPOSITS - Shallow marine sediment consisting of material eroded from the land surface.

THREATENED SPECIES - Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

TIME [geol] - See Figure G1.1.

TOPOGRAPHY - The general conformation of a land surface, including its relief and the position of its natural and man-made features.

TOTAL HEAD - The height above a datum plane of a column of water. In a groundwater system, it is composed of elevation head, pressure head, and velocity head.

TRANSCURRENT FAULT - A large scale strike - slip fault in which the fault surface is steeply inclined.

UNCONSOLIDATED - (a) Sediment that is loosely arranged or unstratified, or whose particles are not cemented together, occurring either at the surface or at depth. (b) Soil material that is in a loosely aggregated form.

VALLEY - Any low-lying land bordered by higher ground, especially an elongate, relatively large, gently sloping depression of the earth's surface, commonly situated between two mountains or between ranges of hills and mountains, and often containing a stream or river with an outlet. It is usually developed by stream or river erosion, but can be formed by faulting.

WATER TABLE - The level in the saturated zone at which the pressure is equal to the atmospheric pressure.

WETLANDS - Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

WILDERNESS AREA - An area unaffected by anthropogenic activities and deemed worthy of special attention to maintain its natural condition.

Appendix A

Outside Agency Contact List

OUTSIDE AGENCY CONTACT LIST

- 1) Bureau of Economic Geology
University of Texas at Austin
University Station, Box X
Austin, TX 78713
(512) 471-1534
- 2) Department of the Air Force
147th FIG/DE
1057 Ellington Field
Houston, TX 77034-5586
Major Sheila F. Hooten, Base Civil Engineer
(713) 929-2781
- 3) Houston-Galveston Subsidence District
1660 West Bay Area Boulevard
Friendswood, TX 77546
Ron Neighbors or Bud Holschuh
(713) 486-1105
- 4) Texas Parks and Wildlife
Resources Protection Division
4200 Smith School Road
Austin, TX 78744
Robert Spain
Dorinda Sullivan
(512) 448-4311
- 5) Texas Water Commission
P.O. Box 13087
Austin, TX 78711-3087
(512) 463-8028
- 6) Texas Water Development Board
611 South Congress
Austin, TX 78704
Bernie Baker
(512) 445-1425
Richard Preston
(512) 445-1439
- 7) United States Department of Agriculture
Soil Conservation Service
1132A North Dallas Avenue
Lancaster, TX 75146-1620

OUTSIDE AGENCY CONTACT LIST (continued)

- 8) United States Department of Agriculture
 Soil Conservation Service
 8245 Gladys, Suite 201
 Beaumont, TX 77706

- 9) United States Department of Commerce
 National Oceanic and Atmospheric Administration
 National Climatic Data Center
 Federal Building
 Asheville, NC 28801
 (704) 259-0871

- 10) United States Geological Survey
 2320 La Branch Street
 Room 1112
 Houston, TX 77004
 Bob Gabrysch
 (713) 750-1656

- 11) United States Geological Survey
 Water Resources Division
 8011 Cameron Road, Building 1
 Austin, TX 78753

Appendix B

USAF Hazard Assessment Rating Methodology

USAF HAZARD ASSESSMENT RATING METHODOLOGY

The DoD has developed a comprehensive program to identify, evaluate, and control hazardous waste disposal practices associated with past waste disposal techniques at DoD facilities. One of the actions required under this program is to:

Develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts (Reference: DEQPPM 81-5, December 11, 1981).

Accordingly, the USAF has sought to establish a system to set priorities for taking further action at sites based upon information gathered during the PA phase of the IRP.

PURPOSE

The purpose of the site rating model is to assign a ranking to each site where there is suspected contamination from hazardous substances. This model will assist the Air National Guard in setting priorities for follow-up site investigations.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous waste present in sufficient quantity), and (2) potential for migration exists. A site may be deleted from ranking consideration on either basis.

DESCRIPTION OF THE MODEL

Like the other hazardous waste site ranking models, the USAF's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DoD needs.

The model uses data readily obtained during the Preliminary Assessment portion of the IRP. Scoring judgment and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and worst hazards at the site. Sites are given low scores only if there are clearly no hazards. This approach meshes well with the policy for evaluating and setting restrictions on excess DoD properties.

Site scores are developed using the appropriate ranking factors presented in this appendix. The site rating form and the rating factor guidelines are provided at the end of this appendix.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: (1) possible receptors of the contamination, (2) the waste and its characteristics, (3) the potential pathways for contaminant migration, and (4) any effort that was made to contain the waste resulting from a spill.

The receptors category rating is based on four rating factors: (1) the potential for human exposure to the site, (2) the potential for human ingestion of contaminants should underlying aquifers be polluted, (3) the current and anticipated use of the surrounding area, and (4) the potential for adverse effects upon important biological resources and fragile natural settings. The potential for human exposure is evaluated on the basis of the total population within 1000 feet of the site, and the distance between the site and the base boundary. The potential for human ingestion of contaminants is based on the distance between the site and the nearest well, the groundwater use of the uppermost aquifer, and population served by the groundwater supply within 3 miles of the site. The uses of the surrounding area are determined by the zoning within a 1-mile radius. Determination of whether or not critical environments exist within a 1-mile radius of the site predicts the potential for adverse effects from the site upon important biological resources and fragile natural settings. Each rating factor is numerically evaluated (0-3) and increased by a multiplier. The maximum possible score is also computed. The factor score and maximum possible scores are totaled, and the receptors subscore computed as follows: $\text{receptors subscore} = (100 \times \text{factor subtotal} / \text{maximum score subtotal})$.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score while scores for solids are reduced.

The pathways category rating is based on evidence of contaminant migration along one of three pathways: surface water migration, flooding, and groundwater migration. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned, and for direct evidence, 100 points are assigned. If no evidence is found, the highest score among the three possible routes is used. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The scores for each of the three categories are added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Scores for sites with no containment are not reduced. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well-managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the score for the other three categories.

HAZARD ASSESSMENT RATING FORM

NAME OF SITE _____

LOCATION _____

DATE OF OPERATION OR OCCURRENCE _____

OWNER/OPERATOR _____

COMMENTS/DESCRIPTION _____

SITE RATED BY _____

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1000 ft. of site		4		12
B. Distance to nearest well		10		30
C. Land use-zoning within 1-mile radius		3		9
D. Distance to installation boundary		6		18
E. Critical environments within 1-mile radius of site		10		30
F. Water quality of nearest surface water body		6		18
G. Groundwater use of uppermost aquifer		9		27
H. Population served by surface water supply within 3 miles downstream of site		6		18
I. Population served by groundwater supply within 3 miles of site		6		18

Subtotals _____ 180

Receptors subscore (100 x factor score subtotal/maximum score subtotal)

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) _____
2. Confidence level (C = confirmed, S = suspected) _____
3. Hazard rating (H = high, M = medium, L = low) _____

Factor Subscore A (from 20 to 100 based on factor score matrix)

B. Apply persistence factor
Factor subscore A x Persistence Factor = Subscore B

_____ x _____ = _____

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

_____ x _____ = _____

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
---------------	---------------------	------------	--------------	------------------------

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore

- B. Rate the migration potential for 3 potential pathways: Surface water migration, flooding, and groundwater migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water		8		24
Net precipitation		6		18
Surface erosion		8		24
Surface permeability		6		18
Rainfall intensity		8		24

Subtotals _____ 108

Subscore (100 x factor score subtotal/maximum score subtotal)

2. Flooding

		1		3
--	--	---	--	---

Subscore (100 x factor score/3)

3. Groundwater migration

Depth to groundwater		8		24
Net precipitation		6		18
Soil permeability		8		24
Subsurface flows		8		24
Direct access to groundwater		8		24

Subtotals _____ 114

Subscore (100 x factor score subtotal/maximum score subtotal)

C. Highest pathway score

Enter the highest subscore value from A, B-1, B-2, or B-3 above

Pathways subscore

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors
Waste Characteristics
Pathways

Total _____ divided by 3 = _____

Gross Total Score

- B. Apply factor for waste containment from waste management practices.

Gross Total Score x Waste Management Practices Factor = Final Score

_____ x _____ =

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

1. RECEPTORS CATEGORY

Rating Factors	Rating Scale Levels			Multiplier
	0	1	2	3
A. Population within 1,000 feet (includes on-base facilities)	0	1-25	26-100	Greater than 100
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet
C. Land use/zoning (within 1-mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or Industrial	Residential
D. Distance to Installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet
E. Critical environments (within 1-mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands
F. Water quality/use designation of nearest surface water body	Agricultural or industrial use	Recreation, propagation and management of fish and wildlife	Shellfish propagation and harvesting	Potable water supplies
G. Groundwater use of uppermost aquifer	Not used, other sources readily available	Commercial, industrial, or irrigation, very limited other water sources	Drinking water, municipal water available	Drinking water, no municipal water available, commercial, industrial, or irrigation; no other water source available
H. Population served by surface water supplies within 3 miles downstream of site	0	1-50	51-1,000	Greater than 1,000
I. Population served by aquifer supplies within 3 miles of site	0	1-50	51-1,000	Greater than 1,000

11. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

- S = Small quantity (5 tons or 20 drums of liquid)
- M = Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
- L = Large quantity (20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

C = Confirmed confidence level (minimum criteria below)

- o Verbal reports from interviewer (at least 2) or written information from the records
- o Knowledge of types and quantities of wastes generated by shops and other areas on base

S = Suspected confidence level

- o No verbal reports or conflicting verbal reports and no written information from the records
- o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site

A-3 Hazard Rating

Rating Factors	Rating Scale Levels		
	0	1	2
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2
Ignitability	flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels
			Sax's Level 3
			Flash point less than 80°F
			Over 5 times background levels

Use the highest individual rating based on toxicity, ignitability, and radioactivity and determine the hazard rating.

Hazard Rating Points

- High (H) 3
- Medium (M) 2
- Low (L) 1

II. WASTE CHARACTERISTICS--Continued

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
80	L	C	H
70	H	C	H
	L	S	H
60	S	C	H
	H	C	H
	L	S	H
50	L	C	L
	H	S	H
	S	C	H
	S	S	H
40	H	C	L
	L	S	L
30	S	C	L
	H	S	L
	S	S	H
20	S	S	L

Notes:

For a site with more than one hazardous waste, the waste quantities may be added using the following rules:

Confidence Level

- o Confirmed confidence levels (C) can be added.
- o Suspected confidence levels (S) can be added.
- o Confirmed confidence levels cannot be added with suspected confidence levels.

Waste Hazard Rating

- o Wastes with the same hazard rating can be added.
- o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCH + SCH = LCH if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an MCH designation (60 points). By adding the quantities of each waste, the designation may change to LCH (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Multiply Point Rating
Persistence Criteria

From Part A by the following

Metals, polycyclic compounds,
and halogenated hydrocarbons
substituted and other ring
compounds
Straight chain hydrocarbons
Easily biodegradable compounds

1.0

0.9

0.8

0.4

C. Physical State Multiplier

Physical state

Liquid
Sludge
Solid

Multiply Point Total From

Parts A and B by the following

1.0

0.75

0.50

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, groundwater, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 Potential for Surface Water Contamination

Rating factors	0			1			2			3			Multiplier
	Greater than 1 mile	2,001 feet to a mile	501 feet to 2,000 feet	0 to 500 feet	Greater than 1 mile	2,001 feet to a mile	501 feet to 2,000 feet	0 to 500 feet	Greater than 1 mile	2,001 feet to a mile	501 feet to 2,000 feet	0 to 500 feet	
Distance to nearest surface water (includes drainage ditches and storm sewers)													8
Net precipitation	Less than -10 inches	-10 to +5 inches	+5 to +20 inches	Greater than +20 inches	None	-10 to +5 inches	+5 to +20 inches	Greater than +20 inches					6
Surface erosion													8
Surface permeability	0% to 15% clay (>10 ⁻² cm/sec)	15% to 30% clay (10 ⁻² to 10 ⁻⁴ cm/sec)	30% to 50% clay (10 ⁻⁴ to 10 ⁻⁶ cm/sec)	Greater than 50% clay (<10 ⁻⁶ cm/sec)		15% to 30% clay (10 ⁻² to 10 ⁻⁴ cm/sec)	30% to 50% clay (10 ⁻⁴ to 10 ⁻⁶ cm/sec)	Greater than 50% clay (<10 ⁻⁶ cm/sec)					6
Rainfall intensity based on 1-year, 24 hour rainfall (thunderstorms)	<1.0 inch	1.0 to 2.0 inches	2.1 to 3.0 inches	>3.0 inches		1.0 to 2.0 inches	2.1 to 3.0 inches	>3.0 inches					8
	0-5	6-35	36-49	>50		0-5	6-35	>50					
	0	30	60	100		0	60	100					

B-2 Potential for Flooding

Floodplain	Beyond 100-year floodplain	In 100-year floodplain	In 10-year floodplain	Floods annually	1
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B-3 Potential for Groundwater Contamination

Depth to groundwater	Greater than 500 feet	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 inches	-10 to +5 inches	+5 to +20 inches	Greater than +20 inches	6
Soil permeability	Greater than 50% clay (<10 ⁻⁶ cm/sec)	30% to 50% clay (10 ⁻⁴ to 10 ⁻⁶ cm/sec)	15% to 30% clay 10 ⁻² to 10 ⁻⁴ cm/sec	0% to 15% clay (>10 ⁻² cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high groundwater level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean groundwater level	8
Direct access to groundwater (through faults, fractures, faulty well casings, subsidence, fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	8

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. Waste Management Practices Factor

The following multipliers are then applied to the total risk points (from A):

<u>Waste Management Practice</u>	<u>Multiplier</u>
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Fire Protection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1, or III-B-3, then leave blank for calculation of factor score and maximum possible score.

Appendix C

Site Hazard Assessment Rating Forms and Factor Rating Criteria

HAZARD ASSESSMENT RATING FORM

NAME OF SITE Site No. 1 - Underground Storage Tank at Building 3

LOCATION Approximately 50 feet southeast of Building 3 (Vehicle Parking Shed)

DATE OF OPERATION OR OCCURRENCE 1963-1985

OWNER/OPERATOR 273rd EIS (Nederland Air National Guard Station, Texas)

COMMENTS/DESCRIPTION From 1980 until 1985, this tank was used to store liquid wastes.

SITE RATED BY Science & Technology, Inc.

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1000 ft. of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use-zoning within 1-mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1-mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	2	6	12	18
G. Groundwater use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	3	6	18	18
I. Population served by groundwater supply within 3 miles of site	0	6	0	18

Subtotals 117 180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 65

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large)

S

2. Confidence level (C = confirmed, S = suspected)

C

3. Hazard rating (H = high, M = medium, L = low)

H

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor subscore A x Persistence Factor = Subscore B

$$\begin{array}{rcccl} 60 & & 0.9 & & 54 \\ \hline & \times & & = & \\ \hline \end{array}$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$\begin{array}{rcccl} 54 & & 1.0 & & 54 \\ \hline & \times & & = & \\ \hline \end{array}$$

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
Subscore				0

- B. Rate the migration potential for 3 potential pathways: Surface water migration, flooding, and groundwater migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water	3	8	24	24
Net precipitation	1	6	6	18
Surface erosion	1	8	8	24
Surface permeability	2	6	12	18
Rainfall intensity	3	8	24	24

Subtotals 74 108

Subscore (100 x factor score subtotal/maximum score subtotal) 69

2. Flooding

0	1	0	3
---	---	---	---

Subscore (100 x factor score/3)

3. Groundwater migration

Depth to groundwater	3	8	24	24
Net precipitation	1	6	6	18
Soil permeability	1	8	8	24
Subsurface flows	2	8	16	24
Direct access to groundwater	2	8	16	24

Subtotals 70 114

Subscore (100 x factor score subtotal/maximum score subtotal) 61

C. Highest pathway score

Enter the highest subscore value from A, B-1, B-2, or B-3 above

Pathways subscore 69

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	65
Waste Characteristics	54
Pathways	69
Total 188	divided by 3 = 63
Gross Total Score	

- B. Apply factor for waste containment from waste management practices.

Gross Total Score x Waste Management Practices Factor = Final Score

$$\frac{63}{1} \times 1.0 = 63$$

**Nederland Air National Guard Station
Nederland, Texas**

**USAF Hazard Assessment Rating Methodology
Factor Rating Criteria**

The following is an explanation of the HARM factor rating criteria for the potential site.

I. Receptors

A. Population Within 1000 feet of Site.

Factor Rating 3.

The population within 1000 feet of both sites is over 100. On UTA weekends, the station population is approximately 173 persons.

B. Distance to Nearest Water Well.

Factor Rating 3.

There is an abandoned water well located on the Station at the northeast corner of Building 1. This well is approximately 150 feet away from Site No. 1.

C. Land Use-Zoning (within 1-mile radius).

Factor Rating 3.

The area within a 1-mile radius of Site No. 1 is zoned commercial and residential.

D. Distance to Installation Boundary.

Factor Rating 3.

Site No. 1 is approximately 40 feet away from the Station's east boundary fence line.

E. Critical Environments (within 1-mile radius).

Factor Rating 0.

According to the Texas Parks and Wildlife Department, there are no endangered or threatened species within a 1-mile radius. There are no critical habitats at or near the Station.

F. Water Quality/Use Designation of Nearest Surface Water Body.

Factor Rating 2.

There are canals near the Station which drain into Sabine Lake. Sabine Lake is used for shellfish propagation and harvesting.

G. Groundwater Use of Uppermost Aquifer.

Factor Rating 2.

The groundwater is used for drinking water; however, municipal water is available in the Nederland area.

H. Population Served by Surface Water Supplies Within 3 Miles Downstream of Site.

Factor Rating 3.

The Nederland area obtains the majority of its drinking water from surface water supplies within a 3-mile radius.

I. Population Served by Aquifer Supplies Within 3 Miles Downstream of Site.

Factor Rating 2.

It is believed that between 50 and 1000 persons within a 3-mile radius of Site No. 1 may be using private wells.

II. Waste Characteristics

A-1: Hazardous Waste Quantity - Factor Rating S (Small).
Although the exact quantity released is not known, a small quantity (less than 20 drums) of combined wastes is estimated to have been released at this site.

A-2: Confidence Level - Factor Rating C (Confirmed).
Several interviewees reported that wastes were stored in this underground tank. Previous inventory checks indicated that water was entering the tank.

A-3: Hazard Rating - Factor Rating H (High).
A high hazard rating was assigned because of the high toxicity of the fuels and solvents stored and possibly released at this site.

B. Persistence Multiplier for Point Rating.

Site No. 1 was assigned a persistence multiplier of 0.9, based on the presence of waste products such as solvents, fuels, and thinners. These wastes correspond primarily to the HARM category of "Substituted and Other Ring Compounds."

C. Physical State Multiplier.

A physical state multiplier of 1.0 was applied to this potential site because the substances released were liquids.

III. Pathways Category

A. Evidence of Contamination.

Site No. 1 was given a score of 0 (no evidence) because this potential site is not greatly suspected of being a source of contamination.

B-1 Potential for Surface Water Contamination.

- o Distance to Nearest Surface Water: Factor Rating 3.
Site No. 1 is located within 500 feet of drainage ditches and storm sewers.
- o Net Precipitation: Factor Rating 1.
The average annual net precipitation is approximately 2 inches at the Station.
- o Surface Erosion: Factor Rating 1.
There is slight erosion of soil at Site No. 1.
- o Surface Permeability: Factor Rating 2.
The surface permeability at Site No. 1 is in the range of 4.24×10^{-5} to 1.41×10^{-4} cm/sec, and the soil is 30 to 50 percent clay.
- o Rainfall Intensity Based on 1-year, 24-hour Rainfall: Factor Rating 3.
The rainfall intensity at the Station is approximately 4.3 inches.

B-2 Potential for Flooding.

Factor Rating 0.
The Station is located beyond the 100-year flood plain of local streams.

B-3 Potential for Groundwater Contamination.

- o Depth to Groundwater: Factor Rating 3.
The depth to groundwater at the Station fluctuates with the seasons but is usually less than 10 feet.
- o Net Precipitation: Factor Rating 1.
See B-1.
- o Soil Permeability: Factor Rating 1.
At Site No. 1, the soil is 30 to 50 percent clay, and the permeability is in the range of 4.24×10^{-5} to 1.41×10^{-4} cm/sec.
- o Subsurface Flows: Factor Rating 2.
The bottom of Site No. 1 is frequently submerged.
- o Direct Access to Groundwater: Factor Rating 2.
Direct access to groundwater through faults, fractures, faulty well casings, subsidence, etc., is a moderate risk for Site No. 1 because of the abandoned well on the Station. The condition of the well and the method of the abandonment are not known.

IV. Waste Management Practices Factor

A multiplier of 1.0 is applied to Site No. 1 because it has no form of containment.

Appendix D

Soil Borings at the Station

FIELD AND LABORATORY PROCEDURES

FIELD PROCEDURES

All borings were drilled with rotary type drilling rigs on the dates and to the depths shown on the boring logs. The boring locations are shown on the Plan of Borings, Figure 1. Samples were taken continuously for the first ten (10) feet of depth and at five (5) feet intervals thereafter to the bottom of the borings. Where possible, the borings were dry augered until water was encountered in each boring in order to secure reliable data on ground water levels.

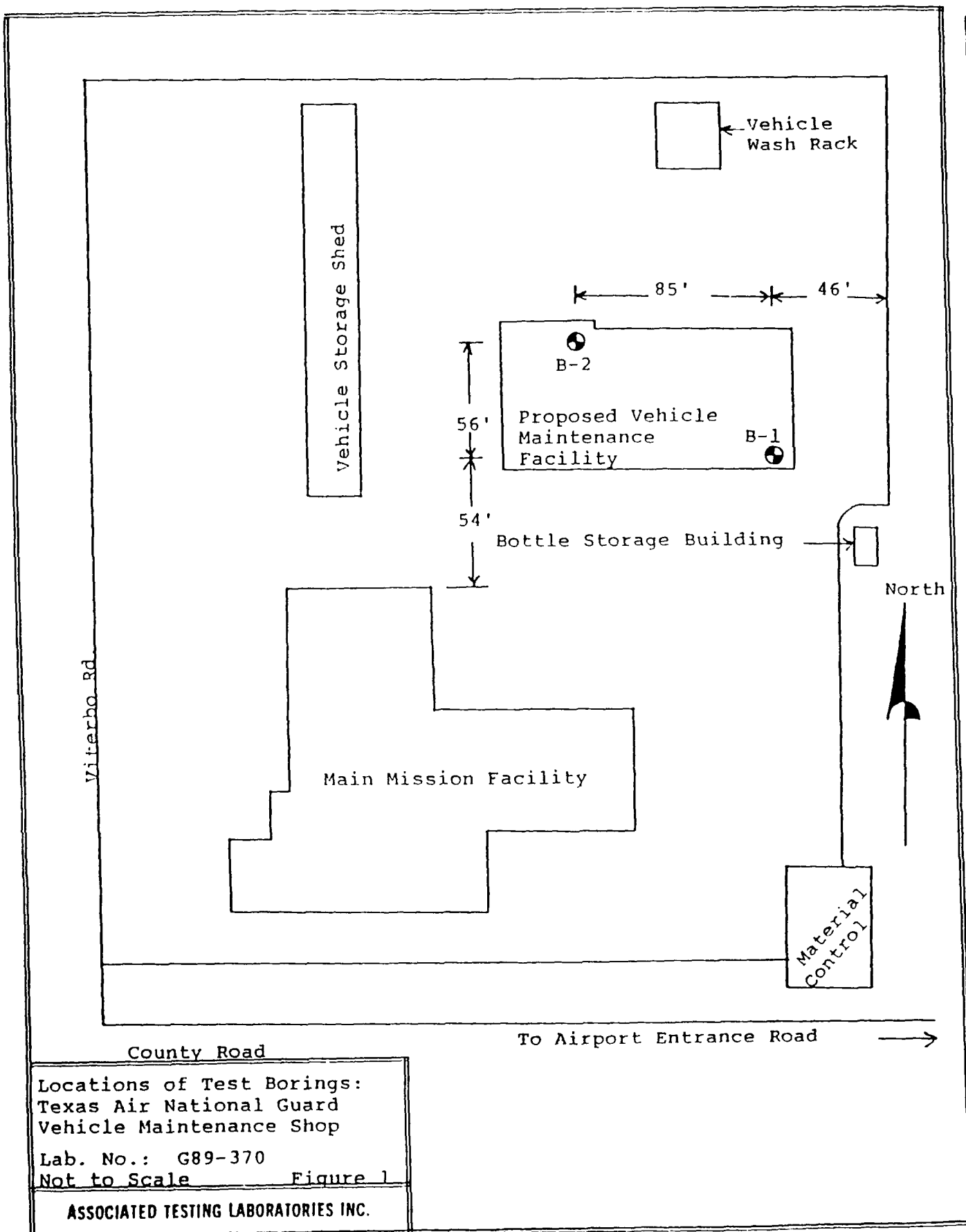
Cohesive soils were sampled by pushing 3-inch diameter thin-wall steel core barrels (shelby tubes) into the undisturbed soil at the bottom of each boring as the drilling progressed. The penetration resistance of each undisturbed core sample was determined in the field using a pocket penetrometer. The samples were then extruded, visually classified, marked and prepared for transport to the laboratory.

Cohesionless soils were sampled by a 2-inch OD, 1.375 inch ID split spoon sampler. The sampler was driven by a 140 pound hammer dropped 30 inches free fall. The blows are recorded in three 6-inch increments; the first 6 inches is driven to seat the sampler the last 12 inches is driven and the number of blows required is recorded. The sample is then prepared for transport to the laboratory.

LABORATORY PROCEDURES

Laboratory testing consist primarily of Moisture Contents, Atterberg Limits and Unconfined Compression Tests. All tests are assigned by a soils engineer to provide a testing program consistent with the project requirements and soil conditions. The test results are presented in the appropriate columns of the boring logs.

REPORT NO. G89-371



LOG OF BORING BORING NO: B-1

PROJECT: VEHICLE MAINTENANCE SHOP
FOR: SLI DESIGN, INC.

JOB NO: G89-370

BORING METHOD:

AUGER: X

DATE: 11-30-89

WASH:

DRILLER: H.S.

GROUND ELEV: EXISTING

Depth (feet)	Sample Method	Water Levels	Penetrometer or Blow Count	Compressive Strength Tons/Sq. Ft.	Moisture Content (%)	Dry Density Lbs./Cu. Ft.	Liquid Limit %	Plasticity Index	<div> <input type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> Standard Penetration Test <input checked="" type="checkbox"/> No Recovery <input type="checkbox"/> Initial Water Level <input type="checkbox"/> Water Level After </div>
					21				Gray & tan clay w/sand seams & org.
			1.5	1.05	22	99	73	51	...stiff below 2'
5			.75		28				...firm below 4'
			1.25		23	96	95	69	...stiff, brownish yellow & light gray below 6'
			.75	.69	22				...firm below 8'
10							27		...dark gray clay below 10'
			2.25				22		...very stiff, gray & tan with calcareous nodules below 13'
15									Boring terminated at 15'
									No water encountered

LOG OF BORING

BORING NO: B-2

PROJECT: VEHICLE MAINTENANCE SHOP
FOR: SLI DESIGN, INC.

JOB NO: G89-370

BORING METHOD: X
AUGER: X

DATE: 11-30-89
DRILLER: H.S.

WASH: EXISTING
GROUND ELEV:

Depth (feet)	Sample Method	Water Levels	Penetrometer or Blow Count	Compressive Strength Tons/Sq. Ft.	Moisture Content (%)	Dry Density Lbs./Cu. Ft.	Liquid Limit %	Plasticity Index	<input type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> Standard Penetration Test <input checked="" type="checkbox"/> No Recovery <input type="checkbox"/> Initial Water Level <input type="checkbox"/> Water Level After
			2.25	1.99	21	103	54	35	Dark gray clay (w/4-6" of asphalt & limestone base) ...very stiff below 2'
5			1.75	1.12	26	99	92	67	...stiff below 4'
			1.5		29				...very stiff, brownish yellow & light gray below 6'
10			2.5		20				
			3.0		19				...hard with calcareous nodules below 13'
15									Boring terminated at 15' No water encountered

KEY TO SOIL CLASSIFICATIONS AND SYMBOLS

BASIC SYMBOLS



Predominant type shown heavy

TERMS DESCRIBING CONSISTENCY OR CONDITION COARSE GRAINED SOILS

(Major portion retained on No. 200 sieve)

Includes (1) clean gravels and sands described as fine, medium or coarse, depending on distribution of grain sizes and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

Descriptive Term	Relative Density*
Loose	0 to 40%
Medium dense	40 to 70%
Dense	70 to 90%
Very dense	90 to 100%

*From tests on undisturbed sand sample.

FINE GRAIN SOILS

(Major portion passing No. 200 sieve)

Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

Descriptive Term	Compressive Strength Tons/sq. ft.
Very soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very stiff	2.00 to 3.00
Hard	3.00 and higher

Note: Silty clays and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or shrinkage cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	-having inclined planes of weakness that are slick and glossy in appearance.
Fissured	-containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Sensitive	-pertaining to cohesive soils that are subject to appreciable loss of strength when remolded.
Laminated	-composed of thin layers of varying color and texture.
Interbedded	-composed of alternate layers of different soil types.
Calcareous	-containing appreciable quantities of calcium carbonate.
Well graded	-having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded	-predominantly of one grain size, or having a range of sizes with some intermediate size missing.

Terms used in this report for describing soils according to their texture or grain size distribution are in accordance with the Unified Soil Classification System, as described in Technical Memorandum No. 3-357, Waterways Experiment Station, March 1959.

ASSOCIATED TESTING LABORATORIES, INC.